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ENVIRONMENTAL PROTECTION AGENCY

Radiation Office

## INTERNATIONAL NUMERICAL MULTIPLE AND SUBMULTIPLE PREFIXES

| Multiples and submultiples | Prefixes | Symbols | Pronunciations |
|---|---|---|---|
| $10^{12}$ | tera | T | tĕr'a |
| $10^{9}$ | giga | G | jĭ'ga |
| $10^{6}$ | mega | M | mĕg'a |
| $10^{3}$ | kilo | k | kĭl'o |
| $10^{2}$ | hecto | h | hĕk'to |
| 10 | deka | da | dĕk'a |
| $10^{-1}$ | deci | d | dĕs'i |
| $10^{-2}$ | centi | c | sĕn'ti |
| $10^{-3}$ | milli | m | mĭl'i |
| $10^{-6}$ | micro | μ | mi'kro |
| $10^{-9}$ | nano | n | năn'o |
| $10^{-12}$ | pico | p | pē'ko |
| $10^{-15}$ | femto | f | fĕm'to |
| $10^{-18}$ | atto | a | ăt'to |

## SYMBOLS, UNITS, AND EQUIVALENTS

| Symbol | Unit | Equivalent |
|---|---|---|
| Å | angstrom | $10^{-10}$ meter |
| a | annum, year | |
| BeV | billion electron volts | GeV |
| Ci | curie | $3.7 \times 10^{10}$ dps |
| cm | centimeter(s) | 0.394 inch |
| cpm | counts per minute | |
| dpm | disintegrations per minute | |
| dps | disintegrations per second | |
| eV | electron volt | $1.6 \times 10^{-12}$ ergs |
| g | gram(s) | |
| GeV | giga electron volts | $1.6 \times 10^{-3}$ ergs |
| kg | kilogram(s) | 1,000 g = 2.205 lb. |
| $km^2$ | square kilometer(s) | |
| kVp | kilovolt peak | |
| $m^3$ | cubic meter(s) | |
| mA | milliampere(s) | |
| $mCi/mi^2$ | millicuries per square mile | 0.386 $nCi/m^2$ ($mCi/km^2$) |
| MeV | million (mega) electron volts | $1.6 \times 10^{-6}$ ergs |
| mg | milligram(s) | |
| $mi^2$ | square mile(s) | |
| ml | milliliter(s) | |
| mm | millimeter(s) | |
| $nCi/m^2$ | nanocuries per square meter | 2.59 $mCi/mi^2$ |
| pCi | picocurie(s) | $10^{-12}$ curie = 2.22 dpm |
| R | roentgen | |
| rad | unit of absorbed radiation dose | 100 ergs/g |

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# RADIOLOGICAL HEALTH DATA AND REPORTS

Volume 12, Number 2, February 1971

*Radiological Health Data and Reports*, a monthly publication of the Environmental Protection Agency, presents data and reports provided by Federal, State, and foreign governmental agencies, and other cooperating organizations. Pertinent original data and interpretive manuscripts are invited from investigators.

In August 1959, the President directed the Secretary of Health, Education, and Welfare to intensify Departmental activities in the field of radiological health. The Department was assigned responsibility within the Executive Branch for the collation, analysis, and interpretation of data on environmental radiation levels. This responsibility was delegated to the Bureau of Radiological Health, Public Health Service. Pursuant to the Reorganization Plan No. 3 of 1970, effective December 2, 1970, this responsibility was transferred to the Radiation Office of the Environmental Protection Agency which was established by this reorganization.

The Federal agencies listed below appoint their representatives to a Board of Editorial Advisors. Members of the Board advise on general publications policy; secure appropriate data and manuscripts from their agencies; and review those contents which relate to the special functions of their agencies.

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Department of Agriculture
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Environmental Protection Agency
Atomic Energy Commission

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**RADIOLOGICAL HEALTH DATA AND REPORTS**

Published under the direction of

Dr. Joseph A. Lieberman
Acting Commissioner
*Radiation Office*





Address correspondence to the Editor, *Radiological Health Data and Reports, Radiation Office*, 1901 Chapman Avenue, Rockville, Md. 20852.

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ENVIRONMENTAL PROTECTION AGENCY
William D. Ruckelshaus, Administrator

# MISSION: ENVIRONMENTAL

The National Environmental Policy Act of 1969, Public Law 91-190, provides for the development of reports on governmental actions that may have impact on the environment, for the accumulation of data and other information for a continuing analysis of changes or trends, and for an interpretation of their underlying causes.

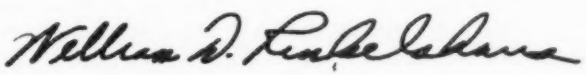
*Radiological Health Data and Reports* was established within the Department of Health, Education, and Welfare in response to a Presidential directive of 1959, providing for the collation, analysis, and interpretation of data on environmental radiation levels. Pursuant to Reorganization Plan No. 3 of 1970, these responsibilities were transferred to the Environmental Protection Agency.

Now in its twelfth year of publication, *Radiological Health Data and Reports* has served governmental agencies, scientific and technical communities, and the public as a qualified source of information in its field, and as a useful record of trends in environmental radiation and its impact on the population.

In projecting future directions for *Radiological Health Data and Reports*, we take into consideration the anticipated growth of nuclear power operations and related activities. We also recognize the interrelationship of all forms of environmental hazard. The role of this journal may well be enlarged to provide a continuing record of data that will help qualified investigators to evaluate the total impact of environmental hazards in a highly complex technological society.

Any future expanded role of *Radiological Health Data and Reports* will develop as we progress in formulating systematic procedures to correlate the findings of studies and surveys relating to ecological systems and environmental quality. In pursuit of these aims, the cooperation of investigators at all levels of government, and that of other involved organizations, will be sought.

We look forward to continued, responsible service in providing competent information about activities relating to the quality of the environment.



William D. Ruckelshaus
Administrator
Environmental Protection Agency

# Reports

## The Uptake of Cerium-144, Promethium-147, and Plutonium-238 by Oat Plants from Soils

*S. L. Cummings and L. Bankert*[1]

The uptakes of cerium-144, promethium-147, and plutonium-238 by oat plants were determined for nine soils, and promethium-147 and plutonium-238 uptakes were compared with cerium-144 uptake. The percentage uptake values for all three radionuclides were very low, ranging from $10^{-6}$ to $10^{-3}$ percent. Nitrogen and potassium fertilizers increased the uptake of promethium-147 by oat plants from an Amite soil. Because the amount of cerium-144, promethium-147, and plutonium-238 taken up by plants from soils is very small, the health hazards to man by the soil-plant-man pathway from these radionuclides will probably be negligible at the levels used in this study.

With the uses and proposed uses of radionuclides as heat sources in auxiliary space batteries, it is important to know to what extent these radionuclides will be taken up from soils by plants in the event a land area becomes contaminated from an abortive flight. Two radionuclides of interest for which very limited information is available on plant uptake from soils are promethium-147 and plutonium-238 (*1,2*).

Since sample preparation for counting plutonium-238 (primarily an alpha emitter) and promethium-147 (primarily a beta emitter) involves much more time than for gamma-emitting radionuclides and since the maximum permissible body burden of plutonium-238 is quite low, it would be advantageous to be able to relate promethium-147 and plutonium-238 uptake by plants from soils to some radionuclide, e. g., cerium-144, that is easily prepared for counting and much less hazardous to handle when performing plant uptake experiments. Therefore, the objectives of this study were to determine to what extent promethium-147 and plutonium-238 are taken up from different soils and to see if this uptake could be related to cerium-144 uptake.

### *Materials and methods*

Properties and collection locations of the soils used in this investigation are given in table 1. One-pint plastic cottage cheese containers (80 $cm^2$ surface area) were used to contain the soils for the plant uptake experiments. The containers were partially filled with soil leaving approximately 1 cm of space at the top. The activity (100 $\mu$Ci of cerium-144 chloride, 100 $\mu$Ci of promethium-147 chloride, and 50 $\mu$Ci of plutonium-238 nitrate solution) was uniformly applied to the

**Table 1. Soil properties**

| Soil series | Cation exchange capacity (meq/100 g) | Organic matter (percent) | pH |
|---|---|---|---|
| Fox (Ohio) | 9.15 | 2.7 | 7.3 |
| Blanton (Florida) | 2.62 | 2.7 | 5.4 |
| Lakeland (Florida) | 1.75 | 2.2 | 5.5 |
| Adamsville (Florida) | 3.02 | 1.3 | 5.9 |
| Ruskin (Florida) | 4.63 | 3.0 | 5.6 |
| Leon (Florida) | 1.53 | 6.1 | 5.5 |
| Congaree (Alabama) | 3.49 | 2.5 | 5.5 |
| Ochlockonee (Alabama) | 8.80 | 1.8 | 5.9 |
| Amite (Alabama) | 2.67 | 1.6 | 6.3 |

[1] Mr. Cummings and Mr. Bankert are with Environmental Protection Agency, Radiation Office, Southeastern Radiological Health Laboratory, P.O. Box 61, Montgomery, Ala. 36101.

soil surface of the partially filled container and additional soil added so that the activity was 1 cm below the soil surface (*3*). Each soil was replicated three times for each radionuclide. One soil (Amite) was used to determine the effect of nitrogen, phosphorus, and potassium on the uptake of promethium-147. Nitrogen, phosphorus, and potassium salts, separately and in combination, were thoroughly mixed with the soil. Thirty oat seeds (*Avena sativa* var. Suregrain) were planted in each container. Oats were chosen as an indicator crop because of their rapid growth and thinned to 20 plants after emergence. The containers were randomly placed in a controlled environment chamber maintained at day and night temperatures of 25° and 18° C, respectively, and day and night relative humidities of 62 and 75 percent, respectively, with a 14-hour photoperiod. Soil moisture tension was adjusted to 0.1 bar by daily watering. Shoots of all plants were collected 3 weeks after planting. Cerium-144 was determined by gamma spectroscopy on dried samples (70° C). Promethium-147 and plutonium-238 levels were determined with an internal proportional counter after the plants had been dry ashed. The soil cation exchange capacity, organic matter content, and pH (1:1 soil-water ratio) were determined by previously published procedures (*3,4*).

*Results and discussion*

The percentage uptakes of cerium-144, promethium-147, and plutonium-238 by oat plants from all soils were very low (table 2). Some of these values were as much as six orders of magnitude lower than strontium-85 and cesium-137 oat plant percentage uptakes from the same soils (*3*). The uptake of cerium-144 was greater than promethium-147 from six of the nine soils and greater than plutonium-238 from all nine soils. These results are in general agreement with previous work (*1,2*).

The linear correlation coefficient of promethium-147 uptake with respect to cerium-144 uptake was 0.95 and plutonium-238 uptake with respect to cerium-144 uptake was 0.47. The relationship between cerium-144 and promethium-147 is quite good and much better than the cerium-144 and plutonium-238 relationship. Although these results are for a limited number of soils, they can be used as a guide to future plant uptake studies with these radionuclides. Additional work with more soils will help verify these results.

An Amite soil was used to determine the effect of nitrogen, phosphorus, and potassium fertilizer salts on oat plant uptake of promethium-147 because of the limited amount of this type of information available for this radionuclide (*5*). The results are given in table 3. Nitrogen and potassium fertilization increased promethium-147 uptake while phosphorus had no significant effect. Nitrogen had a greater enhancing effect than did potassium for this particular soil.

Because the soil-to-plant as well as the food-to-man (*6*) transfer of these three radionuclides is very small, the possible health hazards to man from this pathway would likely be negligible

**Table 2. Percentage uptake of cerium-144, promethium-147, and plutonium-238 by oat plants**

| Soil series | Percentage uptake[a] | | |
|---|---|---|---|
| | Cerium-144 ($\times 10^{-4}$) | Promethium-147 ($\times 10^{-4}$) | Plutonium-238 ($\times 10^{-4}$) |
| Fox (Ohio) | [b]0.33±0.07 | 0.58±0.06 | 0.07±0.01 |
| Blanton (Florida) | 13.1 ±1.4 | 7.8 ±2.1 | .10± .04 |
| Lakeland (Florida) | 14.6 ±1.7 | 10.5 ± .72 | .61± .10 |
| Adamsville (Florida) | 2.56± .85 | .92± .08 | 1.20± .37 |
| Ruskin (Florida) | 2.70± .16 | .96± .13 | .53± .24 |
| Leon (Florida) | 5.00± .33 | 2.76± .25 | .40± .20 |
| Congaree (Alabama) | 26.5 ±2.9 | 33.9 ±3.6 | 2.2 ±1.1 |
| Ochlockonee (Alabama) | 8.7 ±1.9 | 8.92± .21 | .33± .10 |
| Amite (Alabama) | 7.93± .80 | 5.54± .08 | 2.28± .56 |

[a] Percentage uptake is the ratio of the activity in all the plants to the total activity applied to the soil times 100.
[b] Plus or minus 1 standard deviation.

**Table 3. The effect of nitrogen, phosphorus, and potassium on the percentage uptake of promethium-147 by oat plants from an Amite soil**

| Application rate (kg/hectare) | | | Percentage uptake[a] ($\times 10^{-4}$) | Plant weight (mg dry weight) |
|---|---|---|---|---|
| N | P | K | | |
| 0 | 0 | 0 | [b]5.54±0.08 | 605 |
| [c]560 | 0 | 0 | 10.6 ±1.1 | 649 |
| 0 | 0 | [d]560 | 6.66± .66 | 590 |
| [c]560 | 0 | [d]560 | 17.6 ±2.8 | 709 |
| [c]560 | [e]560 | 0 | 9.4 ±1.1 | 712 |
| 0 | [f]560 | [d,f]560 | 4.83± .20 | 641 |
| [c]560 | [f]560 | [d,f]560 | 17.3 ±2.4 | 701 |

[a] Percentage uptake is the ratio of the activity in all the plants to the total activity applied to the soil times 100.
[b] Plus or minus 1 standard deviation.
[c] Ammonium nitrate.
[d] Potassium chloride.
[e] Sodium dihydrogen phosphate.
[f] Potassium dihydrogen phosphate.

at the levels used in this study. This statement may not apply to root crops, which preliminary studies indicate may retain certain isotopes in greater concentrations than the above ground portion.[2]

[2] Personal communication from the Southwestern Radiological Health Laboratory, January 14, 1971.

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# SECTION I. MILK AND FOOD

## Milk Surveillance, October 1970

Although milk is only one of the sources of dietary intake of environmental radioactivity, it is the food item that is most useful as an indicator of the general population's intake of radionuclide contaminants resulting from environmental releases. Fresh milk is consumed by a large segment of the population and contains several of the biologically important radionuclides that may be released to the environment from nuclear activities. In addition, milk is produced and consumed on a regular basis, is convenient to handle and analyze, and samples representative of general population consumption can be readily obtained. Therefore, milk sampling networks have been found to be an effective mechanism for obtaining information on current radionuclide concentrations and long-term trends. From such information, public health agencies can determine the need for further investigation or corrective public health action.

The Pasteurized Milk Network (PMN) sponsored by the Radiation Office, Environmental Protection Agency, and the Office of Compliance, Food and Drug Administration, U.S. Public Health Service, consists of 63 sampling stations; 61 located in the United States, one in Puerto Rico, and one in the Canal Zone. Many of the State health departments also conduct local milk surveillance programs which provide more comprehensive coverage within the individual State. Data from 15 of these State networks are reported routinely in *Radiological Health Data and Reports*. Additional networks for the routine surveillance of radioactivity in milk in the Western Hemisphere and their sponsoring organizations are:

Pan American Milk Sampling Program (Pan American Health Organization and U.S. Environmental Protection Agency)—5 sampling stations

Canadian Milk Network (Radiation Protection Division, Canadian Department of National Health and Welfare)—16 sampling stations

The sampling locations that make up the networks presently reporting in *Radiological Health Data and Reports* are shown in figure 1. Based on the similar purpose for these sampling activities, the present format integrates the complementary data that are routinely obtained by these several milk networks.

### *Radionuclide and element coverage*

Considerable experience has established that relatively few of the many radionuclides that are formed as a result of nuclear fission become incorporated in milk (*1*). Most of the possible


**Figure 1. Milk sampling networks in the Western Hemisphere**

radiocontaminants are eliminated by the selective metabolism of the cow, which restricts gastrointestinal uptake and secretion into the milk. The five fission-product radionuclides which commonly occur in milk are strontium-89, strontium-90, iodine-131, cesium-137, and barium-140. A sixth radionuclide, potassium-40, occurs naturally in 0.0118 percent (*2*) abundance of the element potassium, resulting in a specific activity for potassium-40 of 830 pCi/g total potassium.

Two stable elements which are found in milk, calcium and potassium, have been used as a means for assessing the biological behavior of metabolically similar radionuclides (radiostrontium and radiocesium, respectively). The contents of both calcium and potassium in milk have been measured extensively and are relatively constant. Appropriate values and their variations, expressed in terms of 2-standard deviations ($2\sigma$), for these elements are $1.16 \pm 0.08$ g/liter for calcium and $1.51 \pm 0.21$ g/liter for potassium. These figures are averages of data from the PMN for May 1963–March 1966 (*3*) and were determined for use in general radiological health calculations or discussions.

*Accuracy of data from various milk networks*

In order to combine data from the international, national, and State networks considered in this report, it was first necessary to determine the accuracy with which each laboratory is making its determinations and the agreement of the measurements among the laboratories. The Analytical Quality Control Service of the Radiation Office conducts periodic studies to assess the accuracy of determinations of radionuclides in milk performed by interested radiochemical laboratories. The generalized procedure for making such a study has been outlined previously (*4*).

The most recent study was conducted during May-July 1970, with 28 laboratories participating in an experiment on milk samples containing known concentrations of strontium-89, strontium-90, iodine-131, cesium-137, and barium-140 (*5*). Of the 20 laboratories producing data for the networks reporting in *Radiological Health Data and Reports*, 13 participated in the experiment. The accuracy results of this experiment are shown in table 1. In general, considerable improvement is needed, especially in the accuracy measurements.

**Table 1. Distribution of mean results, quality control experiment**

| Isotope and known concentration | Number of laboratories in each category | | | |
|---|---|---|---|---|
| | Acceptable[a] | Warning level[b] | Unacceptable[c] | Total |
| Strontium-89: High (258 pCi/liter) | 7 (44%) | 1 (6%) | 8 (50%) | 16 |
| Low (15 pCi/liter) | 11 (69%) | 3 (19%) | 2 (12%) | 16 |
| Strontium-90: Intermediate (79.4 pCi/liter) | 13 (57%) | 4 (17%) | 6 (26%) | 23 |
| Low (32.0 pCi/liter) | 5 (25%) | 4 (20%) | 11 (55%) | 20 |
| Iodine-131: High (507 pCi/liter) | 18 (67%) | 2 (7%) | 7 (26%) | 27 |
| Low (49 pCi/liter) | 16 (64%) | 3 (12%) | 6 (24%) | 25 |
| Cesium-137: High (259 pCi/liter) | 20 (74%) | 3 (11%) | 4 (15%) | 27 |
| Low (53 pCi/liter) | 17 (66%) | 5 (19%) | 4 (15%) | 26 |
| Barium-140: High (302 pCi/liter) | 18 (67%) | 2 (7%) | 7 (26%) | 27 |
| Low (33 pCi/liter) | 23 (92%) | 0 | 2 (8%) | 25 |

[a] Measured concentration less than or equal to $2\sigma$ of the known concentration.
[b] Measured concentration greater than $2\sigma$ and less than or equal to $3\sigma$ of the known concentration.
[c] Measured concentration greater than $3\sigma$ of the known concentration.

These possible differences should be kept in mind when considering the integration of data from the various networks.

*Development of a common reporting basis*

Since the various networks collect and analyze samples differently, a complete understanding of several parameters is useful for interpreting the data. Therefore, the various milk surveillance networks that report regularly were surveyed for information on analytical methods, sampling and analysis frequencies, and estimated analytical errors associated with the data.

In general, radiostrontium is collected by an ion-exchange technique and determined by beta-particle counting in low-background detectors, and the gamma-ray emitters (potassium-40, iodine-131, cesium-137, and barium-140) are determined by gamma-ray spectroscopy of whole milk. Each laboratory has its own modifications and refinements of these basic methodologies. The methods used by each of the networks have been referenced in earlier reports appearing in *Radiological Health Data and Reports.*

A previous article (*6*) summarized the criteria used by the State networks in setting up their milk sampling activities and their sample collection procedures as determined during a 1965 survey. This reference and an earlier data article for the particular network of interest may be consulted should events require a more definitive analysis of milk production and milk consumption coverage afforded by a specific network.

Many networks collect and analyze samples on a monthly basis. Some collect samples more frequently but composite the several samples for one analysis, while others carry out their analyses more often than once a month. Many networks are analyzing composite samples on a quarterly basis for certain nuclides. The frequency of collection and analysis varies not only among the networks but also at different stations within some of the networks. In addition, the frequency of collection and analysis is a function of current environmental levels. The number of samples analyzed at a particular sampling station under current conditions is reflected in the data presentation. Current levels for strontium-90 and cesium-137 are relatively stable over short time periods, and sampling frequency is not critical. For the short-lived radionuclides, particularly iodine-131, the frequency of analysis is critical and is generally increased at the first measurement or recognition of a new influx of this radionuclide.

The data presentation also reflects whether raw or pasteurized milk was collected. An analysis of raw and pasteurized milk samples collected during January 1964 to June 1966 indicated that for relatively similar milkshed or sampling areas, the differences in concentrations of radionuclides in raw and pasteurized milk are not statistically significant (*7*). Particular attention was paid to strontium-90 and cesium-137 in that analysis.

Practical reporting levels were developed by the participating networks, most often based on 2-standard deviation counting errors or 2-standard deviation total analytical errors from replicate analyses (*3*). The practical reporting level reflects analytical factors other than statistical radioactivity counting variations and will be used as a practical basis for reporting data.

The following practical reporting levels have been selected for use by all networks whose practical reporting levels are given as equal to or less than the given value.

| Radionuclide | Practical reporting level (pCi/liter) |
|---|---|
| Strontium-89 | 5 |
| Strontium-90 | 2 |
| Iodine-131 | 10 |
| Cesium-137 | 10 |
| Barium-140 | 10 |

Some of the networks gave practical reporting levels greater than those above. In these cases, the larger value is used so that only data considered by the network as meaningful will be presented. The practical reporting levels apply to the handling of individual sample determinations. The treatment of measurements equal to or below these practical reporting levels for calculation purposes, particularly in calculating monthly averages, is discussed in the data presentation.

Analytical error or precision expressed as pCi/liter or percent in a given concentration range have also been reported by the networks (*3*). The precision errors reported for each of the radionuclides fall in the following ranges:

| Radionuclide | Analytical errors of precision (2-standard deviations) |
|---|---|
| Strontium-89 | 1–5 pCi/liter for levels <50 pCi/liter; 5–10% for levels ≥50 pCi/liter; |
| Strontium-90 | 1–2 pCi/liter for levels <20 pCi/liter; 4–10% for levels ≥20 pCi/liter; |
| Iodine-131, Cesium-137, Barium-140 | 4–10 pCi/liter for levels <100 pCi/liter; 4–10% for levels ≥100 pCi/liter. |

For iodine-131, cesium-137, and barium-140, there is one exception for these precision error ranges: 25 pCi/liter at levels <100 pCi/liter for Colorado. This is reflected in the practical reporting level for the Colorado milk network.

*Federal Radiation Council guidance applicable to milk surveillance*

In order to place the U.S. data on radioactivity in milk presented in *Radiological Health Data and Reports* in perspective, a summary of the guidance provided by the Federal Radiation Council for specific environment conditions was presented in the December 1970 issue of *Radiological Health Data and Reports.*

*Data reporting format*

Table 2 presents the integrated results of the international, national, and State networks discussed earlier. Column 1 lists all the stations which are routinely reported to *Radiological Health Data and Reports.* The relationship between the PMN stations and the State stations is shown in figure 2. The first column under each of the radionuclides reported gives the monthly average for the station and the number of samples analyzed in that month in parentheses. When an individual sampling result is equal to or below the practical reporting level for the radionuclide, a value of zero is used for averaging. Monthly averages are calculated using the above convention. Averages which are equal to or less than the

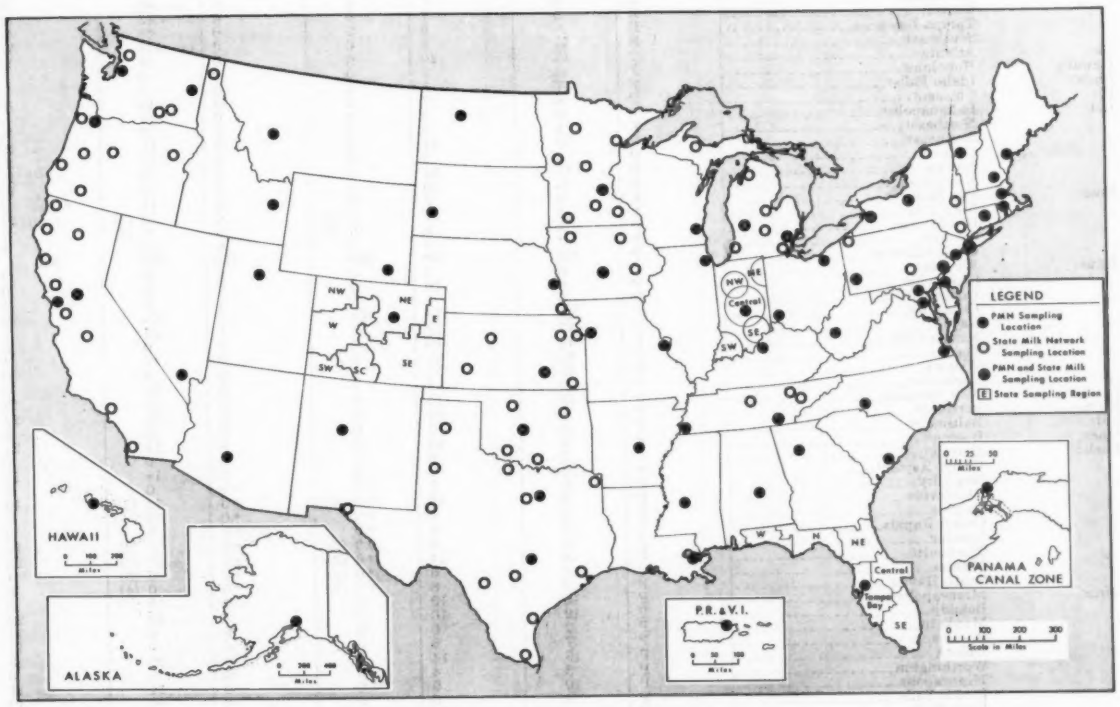


**Figure 2. State and PMN milk sampling stations in the United States**

## Table 2. Concentrations of radionuclides in milk for October 1970 and 12-month period November 1969 through October 1970

| Sampling location | | Type of sample[a] | Radionuclide concentration (pCi/liter) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Strontium–90 | | Iodine–131 | | Cesium–137 | |
| | | | Monthly average[b] | 12-month average | Monthly average[b] | 12-month average | Monthly average[b] | 12-month average |
| UNITED STATES: | | | | | | | | |
| Ala: | Montgomery[c] | P | 10 | 6 | 0 | 0 | 18 | 10 |
| Alaska: | Palmer[c] | P | 6 | 6 | 0 | 0 | 24 | 9 |
| Ariz: | Phoenix[c] | P | 2 | 1 | 0 | 0 | 0 | 0 |
| Ark: | Little Rock[c] | P | 11 | 13 | 0 | 0 | 12 | 17 |
| Calif: | Sacramento[c] | P | 2 | 2 | 0 | 0 | 0 | 0 |
| | San Francisco[c] | P | 3 | 2 | 0 | 0 | 0 | 0 |
| | Del Norte | P | 17 | 17 | 0 | 0 | 5 | 18 |
| | Fresno | P | 2 | 2 | 0 | 0 | 3 | 2 |
| | Humboldt | P | 4 | 5 | 0 | 0 | 0 | 5 |
| | Los Angeles | P | 2 | 2 | 0 | 0 | 0 | 2 |
| | Mendocino | P | 2 | 3 | 0 | 0 | 0 | 3 |
| | Sacramento | P | 3 | 3 | 0 | 0 | 0 | 2 |
| | San Diego | P | 1 | 2 | 0 | 0 | 0 | 1 |
| | Santa Clara | P | 2 | 2 | 0 | 0 | 0 | 1 |
| | Shasta | P | 3 | 3 | 0 | 0 | 0 | 2 |
| | Sonoma | P | 3 | 3 | 0 | 0 | 1 | 3 |
| Colo: | Denver[c] | P | 4 | 5 | 0 | 0 | 0 | 1 |
| | West | R | (d) | | •0 (4) | 1 | •0 (4) | 4 |
| | Northeast | R | (d) | | •0 (8) | 0 | •0 (8) | 0 |
| | East | R | (d) | | •0 | 0 | •0 | 0 |
| | Southeast | R | (d) | | NS | 0 | NS | 0 |
| | South Central | R | (d) | | NS | 0 | NS | 0 |
| | Southwest | R | (d) | | NS | 0 | NS | 7 |
| | Northwest | R | (d) | | 0 | 6 | •0 | 0 |
| Conn: | Hartford[c] | P | 7 | 8 | 0 | 0 | 0 | 12 |
| | Central | P | 7 | 7 | 0 | 0 | 21 | 14 |
| Del: | Wilmington[c] | P | 8 | 9 | 0 | 0 | 11 | 7 |
| D.C: | Washington[c] | P | 5 | 7 | 0 | 0 | 12 | 7 |
| Fla: | Tampa[c] | P | 5 | 6 | 0 | 0 | 55 | 51 |
| | West | R | 10 | 9 | 0 | 0 | 10 | 17 |
| | North | R | 9 | 11 | 0 | 0 | 46 | 25 |
| | Northeast | R | 9 | 7 | 0 | 0 | 49 | 38 |
| | Central | R | 8 | 7 | 0 | 0 | 43 | 49 |
| | Tampa Bay area | R | 6 | 6 | 0 | 0 | 49 | 49 |
| | Southeast | R | 12 | 8 | 0 | 0 | 111 | 73 |
| Ga: | Atlanta[c] | P | 10 | 10 | 0 | 0 | 15 | 17 |
| Hawaii: | Honolulu[c] | P | 4 | 2 | 0 | 0 | 0 | 0 |
| Idaho: | Idaho Falls[c] | P | 7 | 5 | 0 | 0 | 0 | 4 |
| Ill: | Chicago[c] | P | 6 | 7 | 0 | 0 | 16 | 10 |
| Ind: | Indianapolis[c] | P | 9 | 8 | 0 | 0 | 14 | 7 |
| | Northeast | P | 9 | 9 | 0 | 1 | 10 | 14 |
| | Southeast | P | 11 | 11 | 0 | 0 | 15 | 12 |
| | Central | P | 8 | 9 | 0 | 1 | 15 | 10 |
| | Southwest | P | 12 | 12 | 0 | 0 | 10 | 12 |
| | Northwest | P | 10 | 10 | 0 | 0 | 10 | 15 |
| Iowa: | Des Moines[c] | P | 9 | 7 | 0 | 0 | 11 | 2 |
| | Iowa City | P | 9 | 7 | 0 (2) | 0 | 12 (2) | 11 |
| | Des Moines | P | 8 | 8 | 0 (3) | 0 | 9 (3) | 7 |
| | Spencer | P | 7 | 6 | 0 | 0 | 15 | 5 |
| | Fredericksburg | P | NS | NS | NS | NS | NS | NS |
| Kans: | Wichita[c] | P | 6 | 8 | 0 | 0 | 0 | 2 |
| | Coffeyville | P | 8 | 10 | 0 | 0 | 0 | 0 |
| | Dodge City | P | 0 | 8 | 0 | 1 | 0 | 1 |
| | Falls City | P | NS | 14 | NS | 0 | NS | 2 |
| | Hays | P | 17 | 14 | 0 | 1 | 12 | 1 |
| | Kansas City | P | 14 | 10 | 0 | 0 | 0 | 3 |
| | Topeka | P | 18 | 12 | 0 | 0 | 12 | 3 |
| | Wichita | P | 30 | 12 | 0 | 0 | 0 | 0 |
| Ky: | Louisville[c] | P | 8 | 8 | 0 | 0 | 12 | 5 |
| La: | New Orleans[c] | P | 12 | 15 | 0 | 0 | 15 | 19 |
| Maine: | Portland[c] | P | 8 | 10 | 0 | 0 | 26 | 22 |
| Md: | Baltimore[c] | P | 7 | 7 | 0 | 0 | 0 | 8 |
| Mass: | Boston[c] | P | 9 | 10 | 0 | 0 | 17 | 21 |
| Mich: | Detroit[c] | P | 7 | 8 | 0 | 0 | 0 | 9 |
| | Grand Rapids[c] | P | 10 | 9 | 0 | 0 | 14 | 12 |
| | Bay City | P | 7 | 7 | •0 | •0 | 0 | 9 |
| | Charlevoix | P | 9 | 13 | •0 (2) | •0 | 12 (2) | 16 |
| | Detroit | P | 6 | 8 | •0 | •0 | 12 | 7 |
| | Grand Rapids | P | 7 | 9 | •0 | •0 | 0 | 9 |
| | Lansing | P | 9 | 9 | •0 (2) | •0 | 7 (2) | 14 |
| | Marquette | P | 8 | 14 | •0 (2) | •0 | 21 (2) | 23 |
| | Monroe | P | 4 | 6 | •0 (2) | •0 | 0 (2) | 4 |
| | South Haven | P | 9 | 8 | •0 (4) | •0 | 0 (4) | 6 |
| Minn: | Minneapolis[c] | P | 10 | 10 | 0 | 0 | 13 | 9 |
| | Bemidji | P | 10 | 10 | 0 | 0 | 26 | 22 |
| | Mankato | P | 7 | 6 | 0 | 0 | 0 | 11 |
| | Rochester | P | 7 | 6 | 0 | 0 | 0 | 11 |
| | Duluth | P | 13 | 14 | 0 | 0 | 20 | 26 |
| | Worthington | P | 3 | 4 | 0 | 0 | 0 | 0 |
| | Minneapolis | P | 10 | 9 | 0 | 0 | 14 | 15 |
| | Fergus Falls | P | 8 | 6 | 0 | 0 | 16 | 12 |
| | Little Falls | P | 15 | 10 | 0 | 0 | 27 | 31 |

See footnotes at end of table.

## Table 2. Concentrations of radionuclides in milk for October 1970 and 12-month period November 1969 through October 1970—Continued

| Sampling location | | Type of sample[a] | Radionuclide concentration (pCi/liter) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Strontium–90 | | Iodine–131 | | Cesium–137 | |
| | | | Monthly average[b] | 12-month average | Monthly average[b] | 12-month average | Monthly average[b] | 12-month average |
| UNITED STATES—Continued | | | | | | | | |
| Miss: | Jackson[c] | P | 9 | 12 | 0 | 0 | 16 | 12 |
| Mo: | Kansas City[c] | P | 7 | 8 | 0 | 0 | 0 | 2 |
| | St. Louis[c] | P | 9 | 9 | 0 | 0 | 13 | 4 |
| Mont: | Helena[c] | P | 6 | 5 | 0 | 0 | 0 | 6 |
| Nebr: | Omaha[c] | P | 0 | 5 | 0 | 0 | 0 | 1 |
| Nev: | Las Vegas[c] | P | 4 | 2 | 0 | 0 | 0 | 0 |
| N.H: | Manchester[c] | P | 10 | 8 | 0 | 0 | 23 | 19 |
| N.J: | Trenton[c] | P | 8 | 8 | 0 | 0 | 11 | 9 |
| N.Mex: | Albuquerque[c] | P | 3 | 3 | 0 | 0 | 0 | 0 |
| N.Y: | Buffalo[c] | P | 8 | 7 | 0 | 0 | 15 | 9 |
| | New York City[c] | P | 8 | 10 | 0 | 0 | 11 | 16 |
| | Syracuse[c] | P | 7 | 7 | 0 | 0 | 0 | 10 |
| | Albany | P | 11 | 6 | 0 (4) | 0 | 0 (4) | 0 |
| | Buffalo | P | NS | 0 | 0 | 0 | 0 | 0 |
| | Massena | P | 4 | 7 | 0 | 0 | 20 | 0 |
| | Newburg | P | 8 | 7 | 0 (3) | 0 | 0 (3) | 0 |
| | New York City | P | 9 | 8 | 0 | 0 | 0 | 0 |
| | Syracuse | P | •0 | 3 | 0 | 0 | 0 | 0 |
| N.C: | Charlotte[c] | P | 12 | 11 | 0 | 0 | 0 | 13 |
| N.Dak: | Minot[c] | P | 11 | 10 | 0 | 0 | 12 | 14 |
| Ohio: | Cincinnati[c] | P | 6 | 8 | 0 | 0 | 0 | 4 |
| | Cleveland[c] | P | 7 | 9 | 0 | 0 | 11 | 9 |
| Okla: | Oklahoma City[c] | P | 7 | 6 | 0 | 0 | 0 | 5 |
| | Oklahoma City | P | NS | | NS | | NS | |
| | Enid | P | NS | | NS | | NS | |
| | Tulsa | P | NS | | NS | | NS | |
| | Lawton | P | NS | | NS | | NS | |
| | Ardmore | P | NS | | NS | | NS | |
| Oreg: | Portland[c] | P | 5 | 6 | 0 | 0 | 0 | 5 |
| | Baker | P | NA | 4 | •0 | •0 | 17 | 5 |
| | Coos Bay | P | NA | 6 | •0 | •0 | 18 | 14 |
| | Eugene | P | NA | 3 | •0 | •0 | •0 | 4 |
| | Medford | P | NA | 3 | •0 | •0 | •0 | 8 |
| | Portland composite | P | NA | 0 | •0 (2) | •0 | 19 (2) | 8 |
| | Portland local | P | NA | 5 | •0 (3) | •0 | 12 (3) | 6 |
| | Redmond | P | NA | 3 | •0 | •0 | •0 | 3 |
| | Tillamook | P | NA | 6 | •0 | •0 | 24 | 16 |
| Pa: | Philadelphia[c] | P | 8 | 9 | 0 | 0 | 0 | 5 |
| | Pittsburgh[c] | P | 10 | 11 | 0 | 0 | 12 | 12 |
| | Dauphin | P | NS | 7 | NS | 4 | NS | 11 |
| | Erie | P | NS | 11 | NS | 0 | NS | 28 |
| | Philadelphia | P | 9 | 8 | 0 | 3 | 13 | 14 |
| | Pittsburgh | P | 18 | 12 | 0 | 1 | 22 | 19 |
| R.I: | Providence[c] | P | 7 | 9 | 0 | 0 | 20 | 16 |
| S.C: | Charleston[c] | P | 6 | 10 | 0 | 1 | 13 | 19 |
| S.Dak: | Rapid City[c] | P | NA | 7 | NS | 0 | NS | 5 |
| Tenn: | Chattanooga[c] | P | 9 | 9 | 0 | 0 | 0 | 10 |
| | Memphis[c] | P | 7 | 8 | 0 | 0 | 0 | 7 |
| | Chattanooga | P | 8 | 12 | 0 | 0 | 18 | 16 |
| | Clinton | P | 10 | 14 | 0 (2) | 1 | 20 (2) | 16 |
| | Fayetteville | P | NS | 12 | NS | 0 | NS | 10 |
| | Knoxville | P | 5 | 9 | 0 | 0 | 10 | 9 |
| | Nashville | P | 6 | 9 | 0 | 0 | 18 | 9 |
| Tex: | Austin[c] | P | 0 | 2 | 0 | 0 | 0 | 3 |
| | Dallas[c] | P | 4 | 6 | 0 | 0 | 0 | 6 |
| | Amarillo | R | NS | 4 | NS | 0 | NS | 2 |
| | Corpus Christi | R | NS | 4 | NS | 0 | NS | 2 |
| | El Paso | R | NS | 3 | NS | 0 | NS | 0 |
| | Fort Worth | R | 3 | 5 | 0 | 0 | 0 | 0 |
| | Harlingen | R | NS | 3 | NS | 0 | NS | 0 |
| | Houston | R | 4 | 8 | 0 | 0 | 20 | 14 |
| | Lubbock | R | NS | 4 | NS | 0 | NS | 0 |
| | Midland | R | 0 | 2 | 0 | 0 | 0 | 0 |
| | San Antonio | R | NS | 4 | NS | 0 | NS | 0 |
| | Texarkana | R | NS | 8 | NS | 0 | NS | 0 |
| | Tyler | R | NS | 15 | NS | 0 | NS | 17 |
| | Uvalde | R | NS | 2 | NS | 0 | NS | 0 |
| | Wichita Falls | R | NS | 9 | NS | 0 | NS | 5 |
| Utah: | Salt Lake City[c] | P | 4 | 4 | 0 (2) | 0 | 8 (2) | 6 |
| Vt: | Burlington[c] | P | 6 | 8 | 0 | 0 | 14 | 12 |
| Va: | Norfolk[c] | P | 8 | 9 | 0 | 0 | 0 | 9 |
| Wash: | Seattle[c] | P | 6 | 6 | 0 | 0 | 16 | 3 |
| | Spokane[c] | P | 5 | 6 | 0 | 0 | 0 | 1 |
| | Benton County | R | NS | 0 | NS | 0 | NS | 5 |
| | Franklin County | R | 0 | 1 | 0 | 0 | 0 | 3 |
| | Sandpoint, Idaho | R | 13 | 10 | 0 | 0 | 23 | 22 |
| | Skagit County | R | 5 | 6 | 0 | 0 | 0 | 7 |
| W.Va: | Charleston[c] | P | 8 | 8 | 0 | 0 | 0 | 5 |
| Wisc: | Milwaukee[c] | P | 5 | 6 | 0 | 0 | 13 | 11 |
| Wyo: | Laramie[c] | P | 6 | 5 | 0 | 0 | 0 | 1 |

See footnotes at end of table.

**Table 2. Concentrations of radionuclides in milk for October 1970 and 12-month period November 1969 through October 1970—Continued**

| Sampling location | | Type of sample[a] | Radionuclide concentration (pCi/liter) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | Strontium–90 | | Iodine–131 | | Cesium–137 | |
| | | | Monthly average[b] | 12-month average | Monthly average[b] | 12-month average | Monthly average[b] | 12-month average |
| CANADA: | | | | | | | | |
| Alberta: | Calgary | P | NA | | NA | | 17 | 17 |
| | Edmonton | P | NA | | NA | | 23 | 18 |
| British Columbia: | Vancouver | P | NA | | NA | | 21 | 26 |
| Manitoba: | Winnipeg | P | NA | | NA | | 26 | 25 |
| New Brunswick: | Fredericton | P | NA | | NA | | 23 | 21 |
| Newfoundland: | St. John's | P | NA | | NA | | 29 | 35 |
| Nova Scotia: | Halifax | P | NA | | NA | | 24 | 20 |
| Ontario: | Ottawa | P | NA | | NA | | 12 | 13 |
| | Saulte Ste. Marie | P | NA | | NA | | 27 | 32 |
| | Thunder Bay | P | NA | | NA | | 27 | 27 |
| | Toronto | P | NA | | NA | | 9 | 9 |
| | Windsor | P | NA | | NA | | 8 | 10 |
| Quebec: | Montreal | P | NA | | NA | | 12 | 18 |
| | Quebec | P | NA | | NA | | 25 | 26 |
| Saskatchewan: | Regina | P | NA | | NA | | 15 | 14 |
| | Saskatoon | P | NA | | NA | | 17 | 13 |
| CENTRAL AND SOUTH AMERICA: | | | | | | | | |
| Colombia: | Bogota | P | 0 | 0 | 0 | 0 | 0 | 0 |
| Chile: | Santiago | P | 0 | 0 | 0 | 0 | 0 | 0 |
| Ecuador: | Guayaquil | P | 0 | 0 | 0 | 0 | 0 | 0 |
| Jamaica: | Kingston | P | NS | 4 | NS | 0 | NS | 83 |
| Venezuela: | Caracas | P | 3 | 1 | 0 | 0 | 0 | 0 |
| Canal Zone: | Cristobal[c] | P | 0 | 1 | 0 | 0 | 13 | 9 |
| Puerto Rico: | San Juan[c] | P | NA | 3 | NS | 0 | NS | 8 |
| PMN Network average[f] | | | 7 | 7 | 0 | 0 | 8 | 9 |

[a] P, pasteurized milk.
R, raw milk.

[b] When an individual sampling result was equal to or less than the practical reporting level, a value of "0" was used for averaging. Monthly averages less than the practical reporting level reflect the fact that some but not all of the individual samples making up the average contained levels greater than the practical reporting level. When more than one analysis was made in a monthly period, the number of samples in the monthly average is given in parenthesis.

[c] EPA Pasteurized Milk Network station. All other sampling locations are part of the State or National network.

[d] Radionuclide analysis not routinely performed.

[e] The practical reporting levels for these networks differ from the general ones given in the text. Sampling results for the networks were equal to or less than the following practical reporting levels:

Iodine–131: Colorado—25 pCi/liter; Michigan—14 pCi/liter; Oregon—15 pCi/liter
Cesium–137: Colorado—25 pCi/liter; New York—20 pCi/liter; Oregon—15 pCi/liter
Strontium—90: New York—3 pCi/liter

[f] This entry gives the average radionuclide concentrations for the EPA Pasteurized Milk Network stations denoted by footnote [c].

NA, no analysis.
NS, no sample collected.

practical reporting levels reflect the presence of radioactivity in some of the individual samples greater than the practical reporting level.

The second column under each of the radionuclides reported gives the 12-month average for the station as calculated from the preceding 12 monthly averages, giving each monthly average equal weight. Since the daily intake of radioactivity by exposed population groups, averaged over a year, constitutes an appropriate criterion for the case where the FRC radiation protection guides apply, the 12-month average serves as a basis for comparison.

*Discussion of current data*

In table 2, surveillance results are given for strontium-90, iodine-131, and cesium-137 for October 1970 and the 12-month period, November 1969 through October 1970. Except where noted the monthly average represents a single sample for the sampling station. Strontium-89 and barium-140 data have been omitted from table 2 since levels at the great majority of the stations for October 1970 were below the respective practical

reporting levels. The following station averages reflect samples in which strontium-89 and barium-140 were detected: strontium-89; Mo., St. Louis (PMN) 7 pCi/liter; Colombia, Bogata (PAHO), 10 pCi/liter; Chile, Santiago (PAHO) 10 pCi/liter; barium-140; Kans., Hays (State) 13 pCi/liter, Wichita (State) 11 pCi/liter.

Iodine-131 results are included in the table, even though they were generally below practical reporting levels. Because of the lower values reflected by the radiation protection guidance provided by the Federal Radiation Council, levels in milk for this radionuclide are of particular public health interest. In general, the practical reporting level for iodine-131 is numerically equal to the upper value of Range I (10 pCi/liter) of the FRC radiation protection guide.

Strontium-90 monthly averages ranged from 0 to 30 pCi/liter in the United States for October 1970, and the highest 12-month average was 17 pCi/liter (Del Norte, Calif.) representing 8.5 percent of the Federal Radiation Council radiation protection guide. Cesium-137 monthly averages ranged from 0 to 111 pCi/liter in the United States for October 1970, and the highest 12-month average was 73 pCi/liter (southeast Florida), representing 2.0 percent of the guide determined by using the recommendations given in the Federal Radiation Council reports. Of particular interest are the consistently higher cesium-137 levels that have been observed in Florida (*8*) and Jamaica. Iodine-131 results for individual samples were all below the practical reporting level.

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Bureau of Radiological Health
Division of Environmental Sanitation
California State Department of Health

Radiation Protection Division
Canadian Department of National Health and Welfare

Radiological Health Section
Division of Air, Occupational and Radiation Hygiene
Colorado State Department of Health

Radiological Health Services
Division of Medical Services
Connecticut State Department of Health

Radiological and Occupational Health Section
Department of Health and Rehabilitative Services
State of Florida

Bureau of Environmental Sanitation
Division of Sanitary Engineering
Indiana State Board of Health

Division of Radiological Health
Environmental Engineering Services
Iowa State Department of Health

Radiation Control Section
Environmental Health Division
Kansas State Department of Health

Radiological Health Services
Division of Occupational Health
Michigan Department of Health

Radiation Control Section
Division of Environmental Health
State of Minnesota Department of Health

Bureau of Nuclear Engineering
New York State Department of Environmental Conservation

Division of Occupational and Radiological Health
Environmental Health Services
Oklahoma State Department of Health

Environmental Radiation Surveillance Program
Division of Sanitation and Engineering
Oregon State Board of Health

Radiological Health Section
Bureau of Environmental Health
Pennsylvania Department of Public Health

Radiological Health Services
Division of Preventable Diseases
Tennessee Department of Public Health

Division of Occupational Health
Environmental Health Services
Texas State Department of Health

Office of Air Quality Control
Division of Technical Services
Washington State Department of Health

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## Food and Diet Surveillance

Efforts are being made by various Federal and State agencies to estimate the dietary intake of selected radionuclides on a continuing basis. These estimates, along with the guidance developed by the Federal Radiation Council, provide a basis for evaluating the significance of radioactivity in foods and diet.

Networks presently in operation and reported routinely include those listed below. These networks provide data useful for developing estimates of nationwide dietary intakes of radionuclides. Programs reported in *Radiological Health Data and Reports* are as follows.

| Program | Period | Issue |
|---|---|---|
| California Diet Study | April–December 1969 and January–June 1970 | November 1970 |
| Connecticut Standard Diet | July–December 1969 | December 1970 |
| Institutional Diet Samples | April–June 1970 | January 1971 |
| Strontium-90 in Tri-City Diets, *HASL* | June–December 1969 | June 1970 |

## 1. Radionuclides in Institutional Diet Samples July–September 1970

*Bureau of Radiological Health* and
*Food and Drug Administration*

The determination of radionuclide concentrations in the diet constitutes an important element of an integrated program of environmental radiological surveillance and assessment. In recognition of the potential significance of the diet in contributing to total environmental radiation exposures, the Public Health Service initiated its Institutional Diet Sampling Program in 1961. This program is administered by the Bureau of Radiological Health with the assistance of the Office of Compliance, Food and Drug Administration (*1*).

The program was designed to provide estimates of the dietary intake of radionuclides in a selected population group ranging from children to young adults of school age. At the present time, 18 basic institutions and eight auxiliary institutions, distributed geographically as shown in figure 1, are being sampled. The station at St. Louis, Mo., was discontinued because of difficulty in locating a new institution. Previous results showed that the daily dietary intake of teenage girls and children from 9 to 12 years of age were comparable, while teenage boys consumed 20 percent more food per day (*1*, *2*). Consequently, estimates for teenage boys and/or girls can be calculated on the basis of the dietary intakes of children.

In general, the sampling procedure is the same at each institution. Each sample represents the edible portion of the diet for a full 7-day week (21 meals plus soft drinks, candy bars, or other in-between snacks) obtained by duplicating the meals of a different individual each day. Drinking water, not included in the samples, is also sampled periodically. Each daily sample is kept frozen until the end of the collection period and is then packed in dry ice and shipped by air express to either the Southwestern Radiological Health Laboratory, Las Vegas, Nev; the Southeastern Radiological Health Laboratory, Montgomery, Ala; or the Northeastern Radiological Health Laboratory, Winchester, Mass. A detailed description of sam-

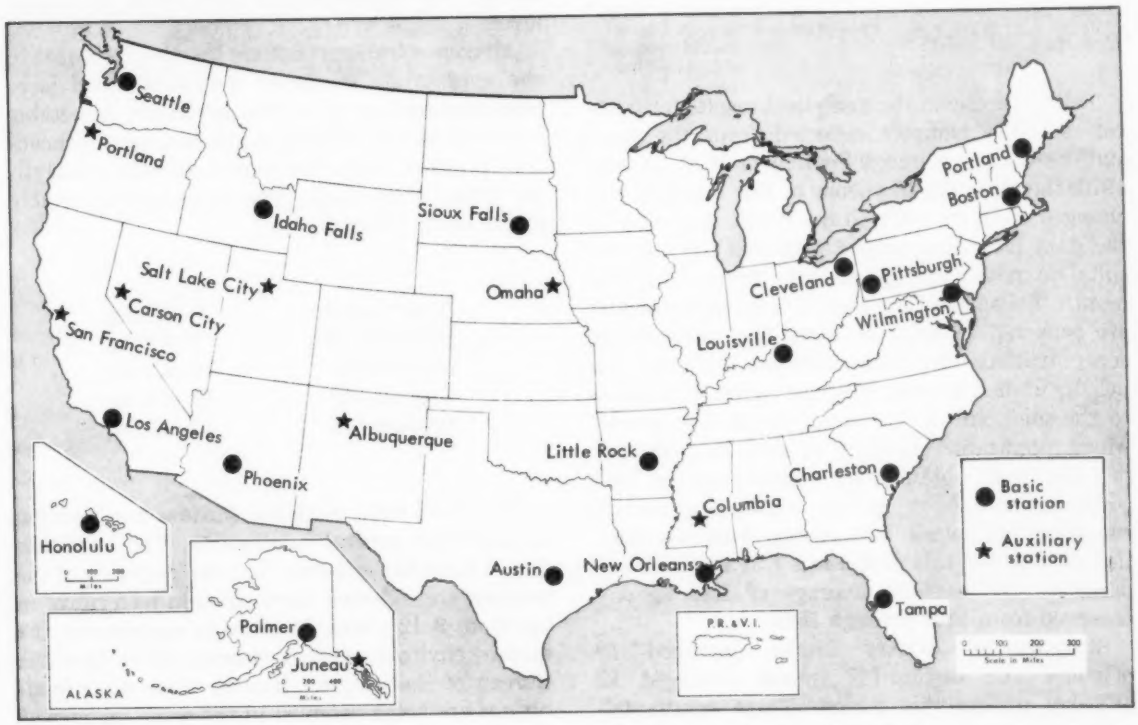


**Figure 1. Institutional diet sampling locations as of September 1970**

**Table 1. Concentrations and intake of stable elements and radionuclides in institutional total diets of children (9–12 years of age), July–September 1970**

| Location of institution | Month (1970) | Total weight (kg/day) | Calcium | | Potassium | | $^{89}Sr$ | | $^{90}Sr$ | | $^{137}Cs$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (g/kg) | (g/day) | (g/kg) | (g/day) | (pCi/kg) | (pCi/day) | (pCi/kg) | (pCi/day) | (pCi/kg) | (pCi/day) |
| Alaska: Palmer | July | 1.04 | 0.4 | 0.4 | 1.6 | 1.6 | 0 | 0 | 3 | 3 | 21 | 22 |
| Ariz: Phoenix | Aug | 1.49 | .3 | .4 | 1.6 | 2.4 | 0 | 0 | 4 | 6 | 0 | 0 |
| Ark: Little Rock | July | 1.11 | .7 | .7 | 1.6 | 1.7 | 0 | 0 | 11 | 12 | 12 | 13 |
| Calif: Los Angeles | July[a] | 1.46 | .6 | .8 | 1.1 | 1.6 | 0 | 0 | 3 | 4 | 0 | 0 |
| Del: Wilmington | July | 2.21 | 1.1 | 2.5 | 1.4 | 3.1 | NA | NA | 6 | 13 | 0 | 0 |
| Fla: Tampa | July | [b].98 | .3 | .3 | 1.4 | 1.4 | 0 | 0 | 5 | 5 | 36 | 35 |
| Hawaii: Honolulu | July | 2.17 | .4 | .9 | 1.4 | 3.0 | 0 | 0 | 2 | 5 | 0 | 0 |
| Idaho: Idaho Falls | July[a] | 2.12 | 1.9 | 4.0 | 1.6 | 3.4 | 0 | 0 | 7 | 15 | 14 | 30 |
| Ky: Louisville | July | 2.37 | .7 | 1.5 | 1.5 | 3.5 | 0 | 0 | 8 | 19 | 0 | 0 |
| La: New Orleans | July[a] | [b].99 | .3 | .3 | 1.1 | 1.1 | 0 | 0 | 3 | 3 | 0 | 0 |
| Maine: Portland | July | 1.41 | 1.6 | 2.2 | 1.5 | 2.1 | NA | NA | 11 | 16 | 21 | 30 |
| Mass: Boston | July | 2.07 | 1.2 | 2.5 | 1.6 | 3.3 | 0 | 0 | 7 | 14 | 14 | 29 |
| Ohio: Cleveland | July | 1.63 | 1.3 | 2.0 | 1.5 | 2.4 | NA | NA | 9 | 15 | 13 | 21 |
| Pa: Pittsburgh | Aug[a] | 2.34 | .5 | 1.2 | 1.5 | 3.5 | NA | NA | 6 | 14 | 12 | 28 |
| S.C: Charleston | July | 1.71 | .5 | .8 | 1.1 | 1.9 | 0 | 0 | 7 | 11 | 0 | 0 |
| S. Dak: Sioux Falls | Sept[a] | 1.17 | .8 | 1.0 | 1.8 | 2.1 | NA | NA | 7 | 8 | 11 | 13 |
| Texas: Austin | July[a] | 1.50 | .7 | 1.0 | 1.5 | 2.2 | 0 | 0 | 3 | 5 | 0 | 0 |
| Wash: Seattle | July[a] | 2.28 | .5 | 1.2 | 1.4 | 3.3 | 0 | 0 | 3 | 7 | 0 | 0 |
| Network average | | 1.67 | 0.8 | 1.3 | 1.5 | 2.4 | 0 | 0 | 6 | 10 | 9 | 12 |

[a] Food samples were collected from two or more children who were not between the ages of 9 and 12.
[b] Milk was not included in this sample.
NA, no analysis.
NOTE: Iodine-131 and barium-140 were not detected at any station during this period.

pling and analytical procedures was presented earlier (*3*).

*Results*

Table 1 presents the analytical results for institutional diet samples collected from the basic stations for July through September 1970. In July 1970, the sampling frequency of this network was changed from monthly to quarterly. A review of the data from this project indicates that the results do not vary significantly from month to month. The stable elements, calcium and potassium are reported in g/kg of diet. The radionuclide concentrations of these samples, reported in pCi/kg of diet, are corrected for radioactive decay to the midpoint of the sample collection period, where applicable. Dietary intakes in g/day or pCi/day were obtained by multiplying the food consumption rate in kg/day by the appropriate concentration values. The average food consumption rate during this period was 1.67 kg/day compared to the network average of 1.87 kg/day observed from 1961 through 1969.

Strontium-90 dietary intake averaged 10 pCi/day and cesium-137 intake averaged 12 pCi/day during this period. These results fall within Range I as defined by the Federal Radiation Council (*4*). Strontium-89, iodine-131, and barium-140 concentrations were below detectable levels.

All concentrations that are less than or equal to the appropriate minimum detectable level have been reported as zero. The minimum detectable concentration is defined as the measured concentration equal to the 2-standard deviation analytical error. Accordingly, the minimum detectable limits are as follows:

| | |
|---|---|
| Strontium-89 | 5 pCi/kg |
| Strontium-90 | 2 pCi/kg |
| Iodine-131 | 10 pCi/kg |
| Cesium-137 | 10 pCi/kg |
| Barium-140 | 10 pCi/kg |

Data from eight auxiliary stations are included in table 2 for general information. These stations do not meet the criterion that the majority of the samples are collected from children who range in age from 9–12 years. In order to supplement the existing environmental monitoring networks of the Bureau of Radiological Health, these eight institutions are being sampled in the same manner as the basic stations.

**Table 2. Concentrations and intake of stable elements and radionuclides in institutional total diets of individuals (auxiliary stations), July–September 1970**

| Location of Institution | Month (1970) | Total weight (kg/day) | Calcium | | Potassium | | $^{89}Sr$ | | $^{90}Sr$ | | $^{137}Cs$ | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | (g/kg) | (g/day) | (g/kg) | (g/day) | (pCi/kg) | (pCi/day) | (pCi/kg) | (pCi/day) | (pCi/kg) | (pCi/day) |
| Alaska: Juneau | Aug | 1.42 | 0.2 | 0.3 | 1.5 | 2.1 | 0 | 0 | 4 | 6 | 32 | 45 |
| Calif: San Francisco | July | 1.91 | .6 | 1.1 | 1.5 | 2.8 | 0 | 0 | 0 | 0 | 0 | 0 |
| Miss: Columbia | July | 2.33 | 1.1 | 2.6 | 1.5 | 3.5 | 0 | 0 | 8 | 18 | 27 | 63 |
| Nebr: Omaha | July | 1.48 | 1.5 | 2.2 | 1.6 | 2.4 | NA | NA | 6 | 9 | 0 | 0 |
| Nev: Carson City | July | 1.41 | .9 | 1.3 | 1.5 | 2.1 | 0 | 0 | 5 | 7 | 23 | 32 |
| N. Mex: Albuquerque | July | 1.90 | .7 | 1.3 | 1.2 | 2.2 | 0 | 0 | 4 | 8 | 0 | 0 |
| Oreg: Portland | July | 1.94 | .6 | 1.1 | 1.7 | 3.3 | 0 | 0 | 3 | 6 | 14 | 27 |
| Utah: Salt Lake City | Aug | 2.10 | .5 | 1.0 | 1.4 | 3.0 | 0 | 0 | 2 | 5 | 0 | 0 |
| Network average | | 1.81 | 0.8 | 1.4 | 1.5 | 2.7 | 0 | 0 | 4 | 7 | 12 | 21 |

NA, no analysis
NOTE: Iodine-131 and barium-140 were not detected at any station during this period.

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Recent coverage in *Radiological Health Data and Reports*:

| Period | Issue |
|---|---|
| October–December 1969 and Annual Summary 1969 | August 1970 |
| January–March 1970 | November 1970 |
| April–June 1970 | January 1971 |

# SECTION II. WATER

The Environmental Protection Agency, the Federal Water Quality Administration and other Federal, State, and local agencies operate extensive water quality sampling and analysis programs for surface, ground, and treated water. Most of these programs include determinations of gross beta and gross alpha radioactivity and specific radionuclides.

Although the determination of the total radionuclide intake from all sources is of primary importance, a measure of the public health importance of radioactivity levels in water can be obtained by comparison of the observed values with the Public Health Service Drinking Water Standards (*1*). These standards, based on consideration of Federal Radiation Council (FRC) recommendations (*2–4*), set the limits for approval of a drinking water supply containing radium-226 and strontium-90 as 3 pCi/liter and 10 pCi/liter, respectively. Limits may be set higher if the total intake of radioactivity from all sources remains within the guides recommended by FRC for control action. In the known absence[1] of strontium-90 and alpha-particle emitters, the limit is 1,000 pCi/liter gross beta radioactivity, except when additional analysis indicates that concentrations of radionuclides are not likely to cause exposures greater than the limits indicated by the Radiation Protection Guides. Surveillance data from a number of Federal and State programs are published periodically to show current and long-range trends. Water sampling activities reported in *Radiological Health Data and Reports* are listed below.

[1] Absence is taken to mean a negligibly small fraction of the specific limits of 3 pCi/liter and 10 pCi/liter for unidentified alpha-particle emitters and strontium-90, respectively.

| Water sampling program | Period reported | Issue |
|---|---|---|
| California | July–December 1968 | August 1970 |
| Minnesota | January–June 1969 | January 1970 |
| New York | January–June 1969 | June 1970 |
| Kansas | January–December 1969 | September 1970 |
| North Carolina | January–December 1967 | May 1969 |
| Radiostrontium in Tap Water, *HASL* | January–December 1969 | July 1970 |
| Tritium in Surface Water | January–June 1970 | November 1970 |
| Washington | July 1967–June 1968 | June 1969 |

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# Radioactivity in Washington Surface Water[1] July 1968-June 1969

*Washington State Department of Social and Health Services*

Radioanalysis of surface water samples collected throughout the State is one of the major functions of the Washington State Department of Social and Health Services radiation surveillance program. Most surface water samples are collected monthly or quarterly by the Washington State Department of Ecology. Selected stations on the Columbia River are sampled weekly or monthly by local health departments. Cedar River, a major water supply for the greater Seattle area, is sampled monthly by the City of Seattle Water Department.

[1] Summarized from "Environmental Radiation Surveillance in Washington State," Eighth Annual Report, July 1968–June 1969.

All water is collected in 2-liter polyethylene bottles by grab sampling and is mailed to the State radiation laboratory in Seattle for analysis. Before sampling, 2 milliliters of concentrated nitric acid are added to each bottle to prevent loss of radioactivity through precipitation or adhesion.

*Analytical procedures*

Surface water samples are analyzed for gamma-ray emitters and then separated into suspended and soluble fractions for gross beta counting. All Columbia River samples are also analyzed for phosphorus-32, a pure beta-particle emitter which is not detectable in the gamma-ray scan. Table 1

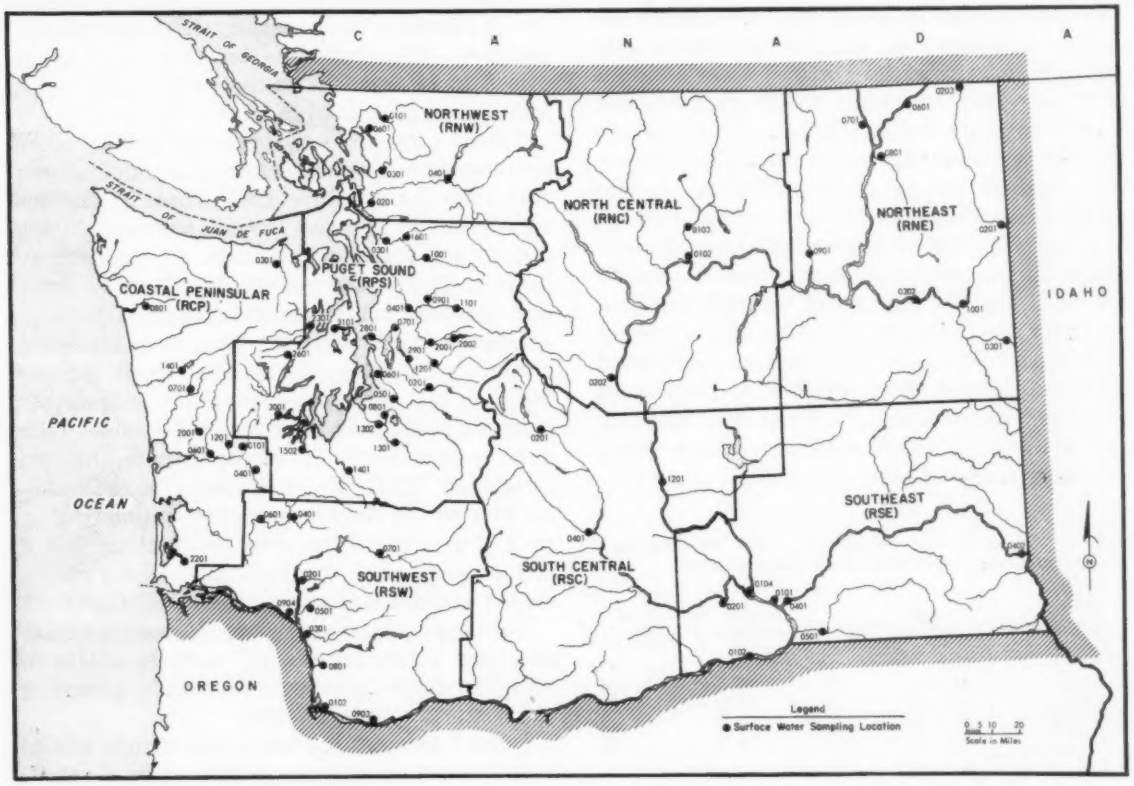


**Figure 1. Washington surface water sampling locations with code numbers**

gives the beta-particle efficiencies and detectability limits for the beta counters. When tritium analysis is desired for selected samples, a 24 ml aliquot of the sample is forwarded to the Environmental Protection Agency's Southwestern Radiological Health Laboratory (SWRHL) for processing.

**Table 1. Beta-particle efficiencies and detectability limits for the Washington State analysis**

| Radionuclide | Efficiency (percent) | Average background (cpm) | Limits of detectability[a] (pCi) |
|---|---|---|---|
| Wide Beta I[b] | | | |
| Strontium-yttrium-90 | 34 | 0.5 | 0.31 |
| Yttrium-90 | 38 | .5 | .28 |
| Phosphorus-32 | 35 | .5 | .30 |
| Wide Beta II[c] | | | |
| Strontium-yttrium-90 | 47 | .8 | .25 |
| Yttrium-90 | 51 | .8 | .23 |
| Phosphorus-32 | 48 | .8 | .24 |

[a] Amount of radiation necessary to produce a net cpm equal to 2 sigma of background, based on 100 minute counts.
[b] The Wide Beta I suffered a major breakdown in March.
[c] The Wide Beta II radiation counter went into operation in April.

For the gamma radioanalysis, the samples are placed in stainless steel Marinelli beakers as soon after receipt as possible. Distilled water is added when necessary to obtain 2,000 ml geometry. Table 2 presents the gamma-ray efficiencies and detectability limits for the gamma spectrometer. After analysis by gamma spectroscopy, surface water (except Columbia River) is filtered through Whatman No. 42 filter paper. The filter paper containing the suspended solids is ashed in a muffle furnace at 600° C., plancheted, weighed, and submitted for gross beta counting. The filtrate, evaporated to near dryness, is quantitatively transferred to a tared planchet, dried, weighed, and submitted for gross beta counting. All gross beta counting takes place 18 days after collection to allow short-lived interfering radionuclides to decay.

**Table 2. Gamma-ray efficiencies and detectability limits for the Washington State analysis**

| Radionuclide | Energy band (MeV) | Efficiency (percent) | Average background (cpm) | Limits of detectability[a] (pCi) |
|---|---|---|---|---|
| Chromium-51 | 0.30−0.36 | 0.52 | 22.79 | 200 |
| Ruthenium-106 | .44− .56 | .91 | 21.65 | 100 |
| Zirconium-95 | .73− .79 | 6.96 | 5.59 | 10 |
| Scandium-46 | .86− .92 | 2.45 | 4.73 | 20 |
| Zinc-65 | 1.05−1.17 | 1.06 | 6.30 | 40 |

[a] Amount of radiation necessary to produce a net cpm equal to 4 sigma of the respective background, based on 100-minute counts.

The gamma analysis of the Columbia River samples is started approximately 14 days after collection. After the gamma spectroscopic analysis, Columbia River samples are divided into two aliquots. One aliquot is prepared for standard gross beta counting as described above, while the second aliquot is prepared for phosphorus-32 counting. The technique used for phosphorus-32 separation is a modification of published methods (*1–4*). After a waiting period of 18 days following collection to allow arsenic-76 and other short-lived interfering radionuclides to decay, the phosphorus is separated from the interfering radionuclides by precipitation as ammonium phosphomolybdate from an acid medium. The precipitate is washed with ammonium nitrate, dissolved with 3N ammonium hydroxide, transferred into a tared planchet, dried, ashed at 450°C., weighed, and counted for beta radioactivity.

*Results*

Table 3 presents the monthly average results for six Columbia River stations which are sampled routinely. In averaging, a less-than value is assumed to be equal to its numerical value and a less-than sign is placed in front of the average.

Table 4 summarizes the beta radioactivity measurements from 23 other surface water stations from July 1968 through June 1969. These 23 stations were reduced to 5 active stations in January 1969, due to the low concentrations of radioactivity present. The second column in this table gives code numbers and the abbreviations denoting geographical sections (figure 1). Each river is assigned a four digit number; the first two digits indicate the river and the second two digits indicate the sampling stations on the river. For example, code number 04 refers to the Snake River in the area designated "RSE," i.e., Southeast. The code number 01 refers to the first sampling station on that river. The third column gives the total number of samples analyzed. Gross beta radioactivity results are not extrapolated to the date of collection.

The network summary gives the maximum and minimum values for the 107 samples analyzed, while the network average is obtained by averaging all the station average values.

Table 5 presents the individual sample results from the tritium analyses performed by SWRHL for the State of Washington.

## Table 3. Monthly average radioactivity in Columbia River water, July 1968–June 1969

| Location and type of analysis | Concentration (pCi/liter) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1968 | | | | | | 1969 | | | | | |
| | July | Aug | Sept | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | June |
| **Northport (code no. RNE 0601)** | | | | | | | | | | | | |
| Beta-particle | | | | | | | | | | | | |
| Suspended[a] | NS | <1 | NS | NS | <1 | NS | NS | 1 | NS | NS | <1 | NS |
| Dissolved[a] | NS | 2 | NS | NS | 2 | NS | NS | 3 | NS | NS | 2 | NS |
| Total | NS | <3 | NS | NS | <3 | NS | NS | 4 | NS | NS | <3 | NS |
| Phosphorus-32[b] | NS | NA | NS | NS | <1 | NS | NS | <1 | NS | NS | <1 | NS |
| Gamma-ray[b] | | | | | | | | | | | | |
| Chromium-51 | NS | <100 | NS | NS | <100 | NS | NS | <100 | NS | NS | <100 | NS |
| Ruthenium-106[c] | NS | <50 | NS | NS | <50 | NS | NS | <50 | NS | NS | <50 | NS |
| Zirconium-95 | NS | <5 | NS | NS | <5 | NS | NS | <5 | NS | NS | <5 | NS |
| Zinc-65 | NS | <20 | NS | NS | <20 | NS | NS | <20 | NS | NS | <20 | NS |
| Scandium-46 | NS | <10 | NS | NS | <10 | NS | NS | <10 | NS | NS | <10 | NS |
| **Richland (code no. RSE 0104)** | | | | | | | | | | | | |
| Beta-particle | | | | | | | | | | | | |
| Suspended[a] | 108(2) | NA | 98(2) | 181(2) | 19(2) | 138(2) | NS | 735 | 66(3) | 100(3) | 34(4) | 947(5) |
| Dissolved[a] | 40(2) | NA | 81(2) | 101(2) | 91(2) | 129(2) | NS | 102 | 157(3) | 74(3) | 47(4) | 133(5) |
| Total[a] | 148 | NA | 179 | 282 | 110 | 267 | NS | 837 | 223 | 174 | 81 | 1,080 |
| Phosphorus-32[b] | 30 | 33 | 101(2) | 118(2) | 101(2) | 176(2) | NS | 114 | 205(3) | 54(3) | 15(4) | 130(5) |
| Gamma-ray[b] | | | | | | | | | | | | |
| Chromium-51 | 1,201(3) | 988 | 2,064(2) | 2,266(2) | 3,012(2) | 3,100(2) | NS | 1,450(3) | 1,750(5) | 724(3) | <396(3) | <3,990(5) |
| Ruthenium-106[c] | <100(3) | <100 | <100(2) | <140(2) | <100(2) | <100(2) | NS | <100(3) | <100(5) | <100(3) | <100(4) | <100(5) |
| Zirconium-95 | <10(3) | <10 | <10(2) | <10(2) | <10(2) | <10(2) | NS | <10(3) | <10(5) | <10(3) | <10(4) | <13(5) |
| Zinc-65 | 113(3) | <40 | 119(2) | <155(2) | 88(2) | 139(2) | NS | 218(3) | 192(5) | 107(3) | <61(4) | <460(5) |
| Scandium-46 | <168(3) | 35 | 193(2) | <318(2) | 45(2) | 507(2) | NS | 215(3) | 243(5) | 108(3) | <64(4) | 1,330(5) |
| **Pasco (code no. RSE 0101)** | | | | | | | | | | | | |
| Beta-particle | | | | | | | | | | | | |
| Suspended[a] | 8 | NA | 41 | 40 | 19 | 25 | 27 | 22 | NA | NS | 16 | 12 |
| Dissolved[a] | 14 | NA | 72 | 52 | 97 | 66 | 78 | 66 | NA | NS | 14 | 24 |
| Total[a] | 22 | NA | 113 | 92 | 116 | 91 | 105 | 88 | NA | NS | 30 | 36 |
| Phosphorus-32[b] | 16 | NA | 80 | 70 | 121 | 93 | 72 | 94 | 99 | NS | 7 | 23 |
| Gamma-ray[b] | | | | | | | | | | | | |
| Chromium-51 | 183 | 1,500 | 1,680 | 1,520 | 2,320 | 1,860 | 1,030 | 1,040 | 497 | NS | <100 | 204 |
| Ruthenium-106[c] | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | NS | <50 | <50 |
| Zirconium-95 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | NS | <5 | <5 |
| Zinc-65 | <20 | 57 | 47 | 51 | 96 | 77 | 73 | 80 | 58 | NS | <20 | 25 |
| Scandium-46 | <10 | 56 | 73 | 64 | 70 | 81 | 74 | 62 | 87 | NS | 45 | 29 |
| **McNary Dam (code no. RSE 0102)** | | | | | | | | | | | | |
| Beta-particle | | | | | | | | | | | | |
| Suspended[a] | 14 | NA | 13 | 18 | 9 | 19 | 14 | NA | 17 | NS | 8 | 18 |
| Dissolved[a] | 13 | NA | 28 | 24 | 23 | 43 | 38 | NA | 47 | NS | 14 | 19 |
| Total | 27 | NA | 41 | 42 | 32 | 62 | 52 | NA | 64 | NS | 22 | 37 |
| Phosphorus-32[b] | 22 | 26 | 35 | 28 | 28 | 56 | 45 | NA | 71 | NS | 11 | 17 |
| Gamma-ray[b] | | | | | | | | | | | | |
| Chromium-51 | 510 | 570 | 866 | 660 | 560 | 1,040 | 803 | 572 | 574 | NS | <100 | 242 |
| Ruthenium-106[c] | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | NS | <50 | <50 |
| Zirconium-95 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | <5 | NS | <5 | <5 |
| Zinc-65 | 23 | <20 | 22 | <20 | <20 | 40 | 40 | 42 | 54 | NS | 43 | 35 |
| Scandium-46 | 22 | 13 | 19 | 26 | 25 | 56 | 38 | 25 | 35 | NS | <10 | 26 |
| **Vancouver (code no. RSW 0102)** | | | | | | | | | | | | |
| Beta-particle | | | | | | | | | | | | |
| Suspended[a] | 7(3) | 3 | 2(3) | 4(2) | 3(2) | 9(3) | 8(2) | 15 | 10 | 11(2) | NS | 9(3) |
| Dissolved[a] | 9(3) | 7 | 9(3) | 12(2) | 10(2) | 15(3) | 15(2) | 21 | 22 | 19(2) | NS | 11(3) |
| Total | 16 | 10 | 12 | 16 | 13 | 24 | 23 | 36 | 32 | 30 | NS | 20 |
| Phosphorus-32[b] | 9(3)[c] | 4 | 7(3) | 10(2) | 8(2) | 18(3) | 17 | 25 | 25 | 21(2) | NS | 10(3) |
| Gamma-ray[b] | | | | | | | | | | | | |
| Chromium-51 | 253(3) | 230 | 446(3) | 498(2) | 369(2) | 531(3) | 408(2) | 495(2) | 304 | 270(2) | NS | <244(3) |
| Ruthenium-106[c] | <50(3) | <50 | <50(3) | <50(2) | <50(2) | <50(3) | <50(2) | <50(2) | <50 | <50(2) | NS | <50(3) |
| Zirconium-95 | <5(3) | <5 | <5(3) | <5(2) | <5(2) | <5(3) | <5(2) | <5(2) | <5 | <5(2) | NS | <5(3) |
| Zinc-65 | <20(3) | <20 | <20(3) | <20(2) | <20(2) | <20(3) | <26(2) | 25(2) | 46 | <20(2) | NS | <23(3) |
| Scandium-46 | <15(3) | <10 | <10(4) | <10(2) | <10(2) | <20(3) | 20(2) | 33(2) | 13 | 18(2) | NS | <10(3) |
| **Longview (code no. RSW 0904)** | | | | | | | | | | | | |
| Beta-particle | | | | | | | | | | | | |
| Suspended[a] | 5(5) | 2(2) | 2(4) | 2(5) | 2(4) | 1(4) | 2(4) | NA | 5(2) | 6(5) | 6(4) | 6(4) |
| Dissolved[a] | 8(5) | 6(2) | 7(4) | 7(5) | 3(4) | 3(4) | 5(4) | NA | 14(2) | 11(5) | 10(4) | 6(4) |
| Total | 13 | 8 | 9 | 9 | 5 | 4 | 7 | NA | 19 | 17 | 16 | 12 |
| Phosphorus-32[b] | 7(5) | 3 | 4(4) | 5(5) | 2(4) | 3(4) | 3 | NA | 16 | 11(5) | 11(4) | 5(4) |
| Gamma-ray[b] | | | | | | | | | | | | |
| Chromium-51 | 245(5) | 215(4) | 327(4) | 277(5) | <142(4) | <135(4) | <115(4) | 210(3) | 240(4) | <155(5) | <142(4) | <119(4) |
| Ruthenium-106[c] | <50(5) | <50(4) | <50(4) | <50(5) | <50(4) | <50(4) | <50(4) | <50(3) | <50(4) | <50(5) | <50(4) | <50(4) |
| Zirconium-95 | <5(5) | <5(4) | <5(4) | <5(5) | <5(4) | <5(4) | <5(4) | <5(3) | <5(4) | <5(5) | <5(4) | <5(4) |
| Zinc-65 | <22(5) | <20(4) | <20(4) | <20(5) | <20(4) | <20(4) | <20(4) | <20(3) | <20(4) | <22(5) | <24(4) | <20(4) |
| Scandium-46 | <10(4) | <10(4) | <10(4) | <10(5) | <10(4) | <10(4) | <10(4) | <13(3) | <11(4) | <11(5) | <11(4) | <10(4) |

[a] Activity at time of counting. Strontium-90-yttrium-90-calibration standard.
[b] Results extrapolated to date of sample collection.
[c] Net activity in the 0.44-0.56 MeV gamma-range is assumed to be only ruthenium-106.
NS, no sample reported. NA, no analysis.

**Table 4. Beta radioactivity in Washington surface water (except for Columbia River), July 1968–June 1969**

| Sampling location | Code number | Number of samples | Concentrations (pCi/liter) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Suspended | | | Dissolved | | | Total | | |
| | | | Average[a] | Minimum | Maximum | Average[a] | Minimum | Maximum | Average[a] | Minimum | Maximum |
| Cedar River | RPS 0201 | 12 | <1 | <1 | <1 | <1 | <1 | 1 | 1 | <1 | 2 |
| Lake Whatcom | RNW 0601 | 12 | <1 | <1 | <1 | 2 | 2 | 3 | 3 | 3 | 4 |
| Lewis River | RSW 0801 | 6 | <1 | <1 | <1 | <1 | <1 | <1 | 1 | <1 | 1 |
| Naches River | RSC 0401 | 6 | <1 | <1 | <1 | <1 | <1 | <1 | 1 | <1 | 1 |
| Naselle River | RCP 2201 | 5 | <1 | <1 | <1 | <1 | <1 | 1 | 1 | <1 | 2 |
| Nisqually River | RPS 1401 | 2 | <1 | <1 | <1 | <1 | <1 | 1 | 1 | <1 | 2 |
| Nooksack River | RNW 0101 | 2 | 9 | <1 | 17 | 2 | 1 | 3 | 11 | 2 | 20 |
| Okanogan River | RNC 0103 | 2 | <1 | <1 | <1 | 2 | 2 | 2 | 3 | 3 | 3 |
| Pend Oreille River | RNE 0201 | 3 | <1 | <1 | <1 | 2 | 2 | 2 | 3 | 3 | 3 |
| Puyallup River | RPS 1302 | 12 | 1 | <1 | 3 | 1 | <1 | 3 | 2 | <1 | 5 |
| Skagit River | RNW 0201 | 6 | <1 | <1 | <1 | 1 | <1 | 2 | 2 | <1 | 3 |
| Snake River | RSE 0401 | 7 | <1 | <1 | 1 | 3 | 2 | 4 | 4 | 3 | 5 |
| | RSE 0402 | 2 | <1 | <1 | <1 | 4 | 4 | 4 | 5 | 5 | 5 |
| Snohomish River | RPS 0401 | 3 | <1 | <1 | <1 | 1 | 1 | 1 | 2 | 2 | 2 |
| Satsop River | RCP 1201 | 2 | <1 | <1 | <1 | <1 | <1 | <1 | 1 | <1 | 1 |
| Spokane River | RNE 0302 | 9 | <1 | <1 | 2 | 2 | 1 | 3 | 3 | 2 | 4 |
| Sultan River | RPS 0901 | 1 | <1 | | | 1 | | | 2 | | |
| Tolt River | RPS 2001 | 2 | <1 | <1 | 1 | <1 | <1 | 1 | 1 | <1 | 2 |
| Toutle River | RSW 0201 | 2 | <1 | <1 | <1 | <1 | <1 | 1 | 1 | <1 | 2 |
| Walla Walla River | RSE 0501 | 2 | <1 | <1 | 1 | 6 | 4 | 9 | 7 | 5 | 10 |
| Wishkah River | RCP 2001 | 5 | <1 | <1 | <1 | <1 | <1 | 1 | 1 | <1 | 2 |
| Wenatchee River | RNC 0202 | 2 | <1 | <1 | <1 | <1 | <1 | 1 | 1 | <1 | 2 |
| Yakima River | RSC 0201 | 2 | <1 | <1 | <1 | <1 | <1 | <1 | 1 | <1 | 1 |
| Network summary | | 107 | <1 | <1 | 17 | 1.3 | <1 | 9 | 2.4 | <1 | 20 |

[a] For averaging purposes, <1 is assumed to be equal to 0.5 pCi/liter.

**Table 5. Tritium in Washington surface water,[a] July 1968–June 1969**

| Sampling location | Code number | Collection date | Concentration (nCi/liter) |
|---|---|---|---|
| Cedar River | RPS 0201 | 2/14/1969 | 0.47 |
| | | 5/22/1969 | <.40 |
| Columbia River: | | | |
| Longview | RSW 0904 | 8/14/1968 | 1.70 |
| | | 11/6/1968 | .50 |
| | | 2/14/1969 | <.40 |
| | | 5/7/1969 | .88 |
| McNary Dam | RSE 0102 | 8/12/1968 | 1.40 |
| | | 11/13/1968 | .46 |
| | | 2/18/1969 | .95 |
| | | 5/20/1969 | .85 |
| Pasco | RSE 0101 | 2/5/1969 | 1.30 |
| | | 5/5/1969 | .96 |
| Richland | RSE 0104 | 2/17/1968 | .71 |
| | | 5/5/1969 | 1.10 |
| Richland (treated) | | 5/5/1969 | 1.00 |
| Vancouver | RSW 0102 | 8/26/1968 | .92 |
| | | 11/4/1968 | .92 |
| | | 2/3/1969 | .70 |
| Lake Whatcom | RNW 0601 | 8/6/1968 | 1.10 |
| | | 11/19/1968 | 1.00 |
| | | 2/11/1969 | .57 |
| | | 5/12/1969 | .56 |
| Lewis River | RSW 0801 | 8/13/1968 | .55 |
| | | 11/12/1968 | .69 |
| Puyallup River | RPS 1302 | 9/11/1968 | <.40 |
| | | 11/18/1968 | <.40 |
| | | 2/10/1969 | <.40 |
| | | 5/14/1969 | <.40 |
| Skagit River | RNW 0201 | 8/6/1968 | 1.10 |
| | | 11/19/1968 | .52 |
| Snake River | RSE 0401 | 2/18/1969 | .54 |
| | | 5/20/1969 | .75 |
| Snohomish River | RPS 0401 | 9/10/1968 | 1.40 |
| Spokane River | RNE 0302 | 8/11/1968 | 1.40 |
| | | 11/11/1968 | .92 |
| | | 2/2/1969 | .65 |
| | | 5/18/1969 | .65 |
| Toutle River | RSW 0201 | 10/21/1968 | .59 |

[a] Analyses performed by SWRHL, Las Vegas, Nev.

*Discussion*

Of the 107 river water samples analyzed from July 1968 through June 1969 (excluding the Columbia River), the total beta radioactivity ranged from <1 to 20 pCi/liter with an average of 2.4 pCi/liter. The radioactivity of the suspended fraction ranged from <1 to 17 pCi/liter with an average of <1 pCi/liter. The radioactivity of the soluble fraction was approximately the same, ranging from <1 to 9 pCi/liter and averaging 1.3 pCi/liter. These network averages during the July 1968 through June 1969 period were lower than the averages for the preceding 12 months. Figure 2 shows the annual average gross beta radioactivity in surface waters other than the Columbia River.

Monthly average total beta radioactivity for the Columbia River stations below the Hanford Facility ranged from 4 to 1,080 pCi/liter. Monthly average concentrations of the beta-particle emitter, phosphorus-32, in the Columbia River water samples taken below the Hanford Facility, ranged from 2 to 205 pCi/liter. Figures 3 and 4 show the gross beta and phosphorus-32 results from the Columbia River at Pasco and Vancouver for 1965 through 1969.

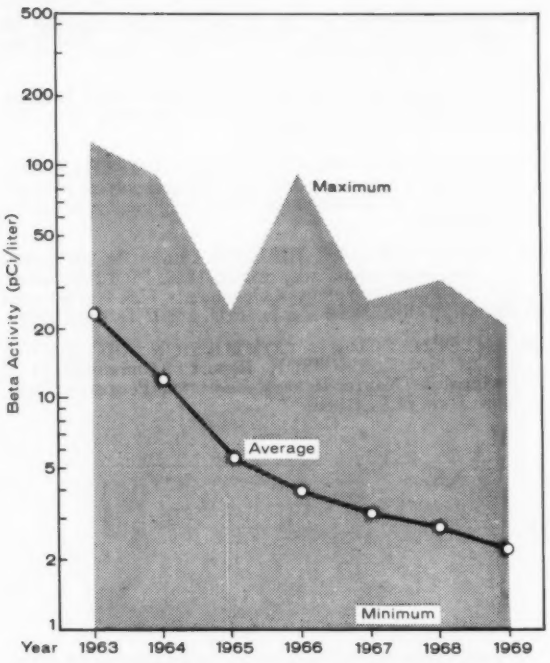


**Figure 2. Average, maximum, and minimum beta radioactivity in surface water (excluding the Columbia river) 1963–1969**

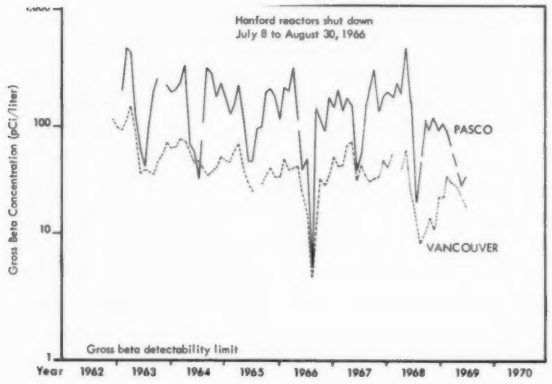


**Figure 3. Gross beta in Columbia River water Pasco and Vancouver**

The gamma-ray emitters, ruthenium-106 and zirconium-95, were found in monthly average concentrations that ranged from <50 to <140 pCi/liter for ruthenium-106 and <5 to <13 pCi/liter for zirconium-95. The values for ruthenium-106 were probably a combination of ruthenium-103 and ruthenium-106. Two other radionuclides, chromium-51 and zinc-65, were found in detectable

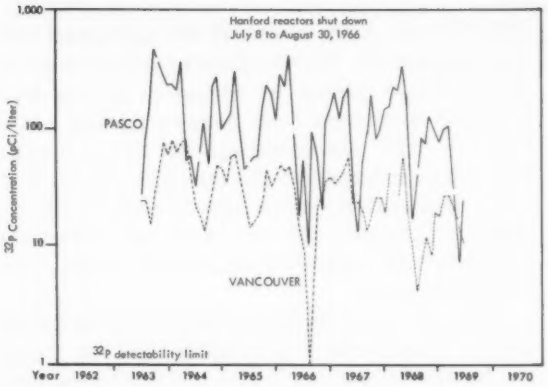


**Figure 4. Phosphorus-32 in Columbia River water Pasco and Vancouver**

quantities in Columbia River water. Monthly averages for chromium-51 ranged from <100 to <3,990 pCi/liter, and for zinc-65 the range was <20 to 460 pCi/liter. Figures 5 and 6 show the results for chromium-51 and zinc-65 at the Pasco and Vancouver stations on the Columbia River for

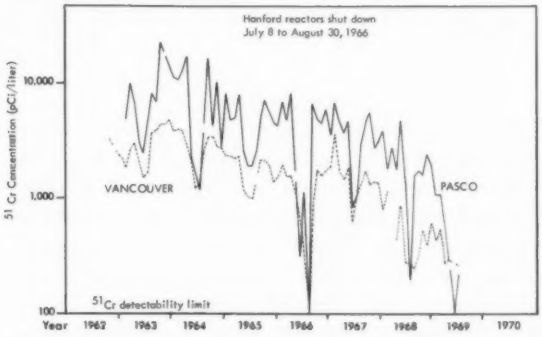


**Figure 5. Chromium-51 in Columbia River water Pasco and Vancouver**

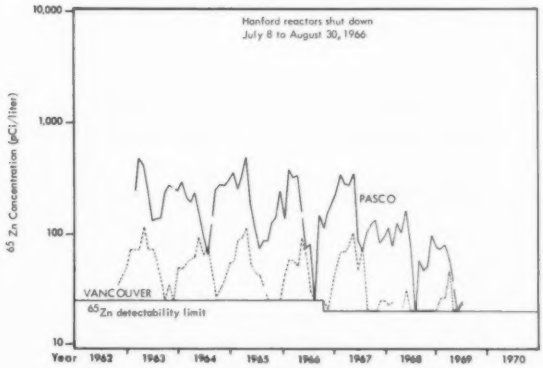


**Figure 6. Zinc-65 in Columbia River water Pasco and Vancouver**

1963 through 1969. It should be emphasized that the radionuclide concentrations found in the Columbia River cannot be compared to low level radiation discharges from modern nuclear power reactors. The concentrations in the Columbia River are due largely to old (up to 25 years), first-technology plutonium production reactors utilizing direct, single-pass cooling and do not reflect the environmental effects that would result from modern reactors.

Although any standards for gross beta radioactivity must be very carefully applied, the standard for drinking water is 1 nCi/liter of gross beta radioactivity in the absence of strontium-90 and alpha emitters (*5*). The standards for water from all dietary sources for the general population at large (*6*) are: chromium-51, 670 nCi/liter; ruthenium-106, 3.3 nCi/liter; zinc-65, 10 nCi/liter; phosphorus-32, 7 nCi/liter.

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(*2*) HILLEBRAND, W. F., G. LUNDELL. Applied Inorganic Analysis. John Wiley and Sons, Inc., New York, N.Y. (1953) pp. 694–710.

(*3*) FURMAN, N. H. Scotts' Standard Method of Analysis, 5th Edition, Vol. 1. Van Nostrand Company, Inc., New York, N.Y. (1944) pp. 694–697.

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(*5*) PUBLIC HEALTH SERVICE. Public Health Service drinking water standards, revised 1962. PHS Publication No. 956, Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402 (August 1963).

(*6*) INTERNATIONAL COMMISSION OF RADIOLOGICAL PROTECTION. Report of Committee II on Permissible Dose for Internal Radiation. Pergamon Press, New York, N.Y. (1959).



Previous coverage in *Radiological Health Data and Reports*:

| Period | Issue |
|---|---|
| July 1967–June 1968 | June 1969 |

# SECTION III. AIR AND DEPOSITION

## Radioactivity in Airborne Particulates and Precipitation

Continuous surveillance of radioactivity in air and precipitation provides one of the earliest indications of changes in environmental fission product radioactivity. To date, this surveillance has been confined chiefly to gross beta radioanalysis. Although such data are insufficient to assess total human radiation exposure from fallout, they can be used to determine when to modify monitoring in other phases of the environment.

Surveillance data from a number of programs are published monthly and summarized periodically to show current and long-range trends of atmospheric radioactivity in the Western Hemisphere. These include data from activities of the Environmental Protection Agency, the Canadian Department of National Health and Welfare, the Mexican Commission of Nuclear Energy, and the Pan American Health Organization.

In addition to those programs presented in this issue, the following programs were previously covered in *Radiological Health Data and Reports.*

| Network | Period | Issue |
|---|---|---|
| Fallout in the United States and Other Areas, *HASL* | January–June 1968 | October 1969 |
| Plutonium in Airborne Particulates and Precipitation, *PHS* | April–December 1969 | October 1970 |

## 1. Radiation Alert Network October 1970

*Air Pollution Control Office*
*Environmental Protection Agency*

Surveillance of atmospheric radioactivity in the United States is conducted by the Radiation Alert Network (RAN) which regularly gathers samples at 70 locations distributed throughout the country (figure 1). Most of the stations are operated by State Health Department personnel.

The station operators perform "field estimates" on the airborne particulate samples at 5 hours after collection, when most of the radon daughter products have decayed, and at 29 hours after collection, when most of the thoron daughter products have decayed. They also perform field estimates on dried precipitation samples and report all results to appropriate Air Pollution Control Office officials by mail or telephone depending on levels found. A compilation of the daily field estimates is available upon request from the Data Acquisition and Analysis Branch, Division of Air Quality and Emission Data, Air Pollution Control Office, EPA, Cincinnati, Ohio. A detailed description of the sampling and analytical procedures was presented in the March 1968 issue of *Radiological Health Data and Reports.*

Table 1 presents the monthly average gross beta radioactivity in surface air particulates and deposition by precipitation, as measured by the field estimate technique, during October 1970. Time profiles of gross beta radioactivity in air for eight Radiation Alert Network stations are shown in figure 2.

All field estimates reported were within normal limits for the reporting station.


**Figure 1. Radiation Alert Network sampling stations**

## Table 1. Gross beta radioactivity in surface air and precipitation, October 1970

| Station location | | Number of samples | Gross beta radioactivity (5-hour field estimate) (pCi/m³) | | | Last profile in RHD&R | Number of samples | Precipitation | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Total depth samples (mm) | Field estimation of deposition | | |
| | | | Maximum | Minimum | Average[a] | | | | Number of samples | Depth (mm) | Total deposition (nCi/m³) |
| Ala: | Montgomery | 21 | 5 | 0 | 1 | Oct 70 | 5 | 163 | 5 | 163 | 55 |
| Alaska: | Anchorage | 1 | 0 | 0 | 0 | Feb 71 | 0 | | | | |
| | Attu Island | 30 | 0 | 0 | 0 | Nov 70 | 0 | | | | |
| | Fairbanks | 16 | 1 | 0 | 0 | July 70 | 9 | 41 | 9 | 41 | 30 |
| | Juneau | 1 | 10 | 10 | 10 | Aug 70 | 0 | | | | |
| | Kodiak | 1 | 0 | 0 | 0 | Sept 70 | 0 | | | | |
| | Nome | 30 | 3 | 0 | 1 | Dec 70 | 0 | | | | |
| | Point Barrow | 0 | | | | Nov 70 | 0 | | | | |
| Ariz: | Phoenix | 7 | 14 | 3 | 5 | Aug 70 | 0 | | | | |
| Ark: | Little Rock | 7 | 4 | 0 | 1 | June 70 | 0 | | | | |
| Calif: | Berkeley | 21 | 2 | 0 | 1 | Sept 70 | 3 | 20 | 3 | 20 | 1 |
| | Los Angeles | 21 | 4 | 0 | 1 | Dec 70 | 0 | | | | |
| C.Z: | Ancon | 4 | 0 | 0 | 0 | Sept 70 | 0 | | | | |
| Colo: | Denver | 19 | 7 | 0 | 2 | Sept 70 | 3 | 15 | [b] | | |
| Conn: | Hartford | 21 | 2 | 0 | 1 | July 70 | 6 | 59 | 5 | 53 | 2 |
| Del: | Dover | 21 | 2 | 0 | 0 | Feb 71 | 0 | | | | |
| D.C: | Washington | 26 | 1 | 0 | 0 | Dec 70 | 0 | | | | |
| Fla: | Jacksonville | 21 | 2 | 0 | 1 | June 70 | 4 | 24 | 4 | 24 | 2 |
| | Miami | 11 | 0 | 0 | 0 | July 70 | 6 | 93 | 6 | 93 | 0 |
| Ga: | Atlanta | 21 | 2 | 1 | 1 | Jan 71 | 1 | 95 | 1 | 95 | 38 |
| Guam: | Agana | 0 | | | | Feb 71 | 0 | | | | |
| Hawaii: | Honolulu | 25 | 3 | 0 | 1 | Nov 70 | 4 | 15 | [b] | | |
| Idaho: | Boise | 23 | 5 | 0 | 2 | Nov 70 | 6 | 29 | 6 | 29 | 0 |
| Ill: | Springfield | 3 | 1 | 1 | 1 | Dec 70 | 0 | | | | |
| Ind: | Indianapolis | 21 | 2 | 0 | 1 | Jan 71 | 0 | | | | |
| Iowa: | Iowa City | 20 | 2 | 0 | 1 | Sept 70 | 3 | 40 | 3 | 40 | 0 |
| Kans: | Topeka | 22 | 3 | 0 | 1 | June 70 | 6 | 56 | 6 | 56 | 7 |
| Ky: | Frankfort | 7 | 1 | 0 | 1 | Dec 70 | 0 | | | | |
| La: | New Orleans | 20 | 1 | 0 | 0 | Aug 70 | 7 | 114 | [b] | | |
| Maine: | Augusta | 21 | 3 | 0 | 1 | Jan 71 | 5 | 65 | 5 | 65 | 0 |
| Md: | Baltimore | 21 | 3 | 0 | 1 | July 70 | 4 | 24 | 4 | 24 | 0 |
| Mass: | Lawrence | 20 | 3 | 0 | 1 | Sept 70 | 5 | 73 | 5 | 73 | 0 |
| | Winchester | 21 | 5 | 0 | 1 | Oct 70 | 5 | 61 | 5 | 61 | 0 |
| Mich: | Lansing | 21 | 3 | 0 | 1 | Nov 70 | 8 | 91 | 8 | 91 | 9 |
| Minn: | Minneapolis | 21 | 2 | 0 | 1 | Feb 71 | 5 | 163 | 5 | 163 | 19 |
| Miss: | Jackson | 17 | 1 | 0 | 0 | Aug 70 | 5 | 364 | 4 | 302 | 17 |
| Mo: | Jefferson City | 21 | 3 | 0 | 1 | Jan 71 | 8 | 102 | 8 | 102 | 0 |
| Mont: | Helena | 21 | 4 | 1 | 1 | Oct 70 | 0 | | | | |
| Nebr: | Lincoln | 17 | 6 | 0 | 2 | Jan 71 | 4 | 118 | 4 | 118 | 23 |
| Nev: | Las Vegas | 20 | 3 | 1 | 1 | July 70 | 0 | | | | |
| N.H: | Concord | 0 | | | | Dec 70 | 0 | | | | |
| N.J: | Trenton | 20 | 3 | 0 | 1 | Aug 70 | 4 | 78 | 4 | 78 | 7 |
| N.Mex: | Santa Fe | 17 | 3 | 0 | 1 | Oct 70 | 8 | 24 | 8 | 24 | 1 |
| N.Y: | Albany | 0 | | | | Jan 71 | 2 | 42 | 2 | 42 | 9 |
| | Buffalo | 19 | 1 | 0 | 0 | Sept 70 | 0 | | | | |
| | New York City | 0 | | | | Oct 70 | 0 | | | | |
| N.C: | Gastonia | 17 | 14 | 1 | 6 | Sept 70 | 4 | 62 | [b] | | |
| N. Dak: | Bismarck | 21 | 6 | 1 | 2 | Dec 70 | 5 | 17 | 5 | 17 | 4 |
| Ohio: | Cincinnati | 0 | | | | Feb 71 | 0 | | | | |
| | Columbus | 2 | 2 | 2 | 2 | Aug 70 | 0 | | | | |
| | Painesville | 19 | 2 | 0 | 1 | July 70 | 0 | 119 | 10 | 119 | 21 |
| Okla: | Oklahoma City | 16 | 5 | 0 | 1 | Nov 70 | 2 | 84 | 2 | 84 | 0 |
| | Ponca City | 21 | 8 | 0 | 2 | July 70 | 6 | 45 | 6 | 45 | 6 |
| Oreg: | Portland | 18 | 2 | 0 | 1 | Jan 71 | 7 | 89 | 7 | 89 | 2 |
| Pa: | Harrisburg | 13 | 2 | 0 | 1 | Feb 71 | 1 | 23 | 1 | 23 | 4 |
| P.R: | San Juan | 0 | | | | Aug 70 | 0 | | | | |
| R.I: | Providence | 21 | 5 | 0 | 1 | Nov 70 | 2 | 19 | 2 | 19 | 1 |
| S.C: | Columbia | 22 | 5 | 0 | 1 | Oct 70 | 2 | 89 | 2 | 89 | 3 |
| S. Dak: | Pierre | 17 | 8 | 1 | 4 | Aug 70 | 0 | | | | |
| Tenn: | Nashville | 15 | 2 | 0 | 1 | Nov 70 | 6 | 101 | 6 | 101 | 6 |
| Tex: | Austin | 0 | | | | Feb 71 | 0 | | | | |
| | El Paso | 2 | 5 | 2 | 4 | Dec 70 | 0 | | | | |
| Utah: | Salt Lake City | 29 | 7 | 0 | 2 | Jan 71 | 5 | 25 | 4 | 18 | 0 |
| Vt: | Barre | 10 | 4 | 0 | 2 | June 70 | 4 | 34 | 4 | 34 | 5 |
| Va: | Richmond | 22 | 2 | 0 | 1 | June 70 | 4 | 36 | 4 | 36 | 21 |
| Wash: | Seattle | 13 | 1 | 0 | 0 | June 70 | 8 | 64 | [b] | | |
| | Spokane | 0 | | | | Feb 71 | 0 | | | | |
| W. Va: | Charleston | 21 | 4 | 0 | 1 | Oct 70 | 7 | 94 | 7 | 94 | 11 |
| Wisc: | Madison | 22 | 2 | 0 | 1 | June 70 | 7 | 55 | 7 | 55 | 4 |
| Wyo: | Cheyenne | 20 | 10 | 0 | 2 | July 70 | 4 | 29 | 4 | 29 | 4 |
| Network summary | | 1,059 | 14 | 0 | 1 | | 210 | 80 | 5 | 71 | 8 |

[a] The monthly average is calculated by weighting the field estimates of individual air samples with length of sampling period.
[b] This station is part of the plutonium in precipitation network. No gross beta measurements are done.

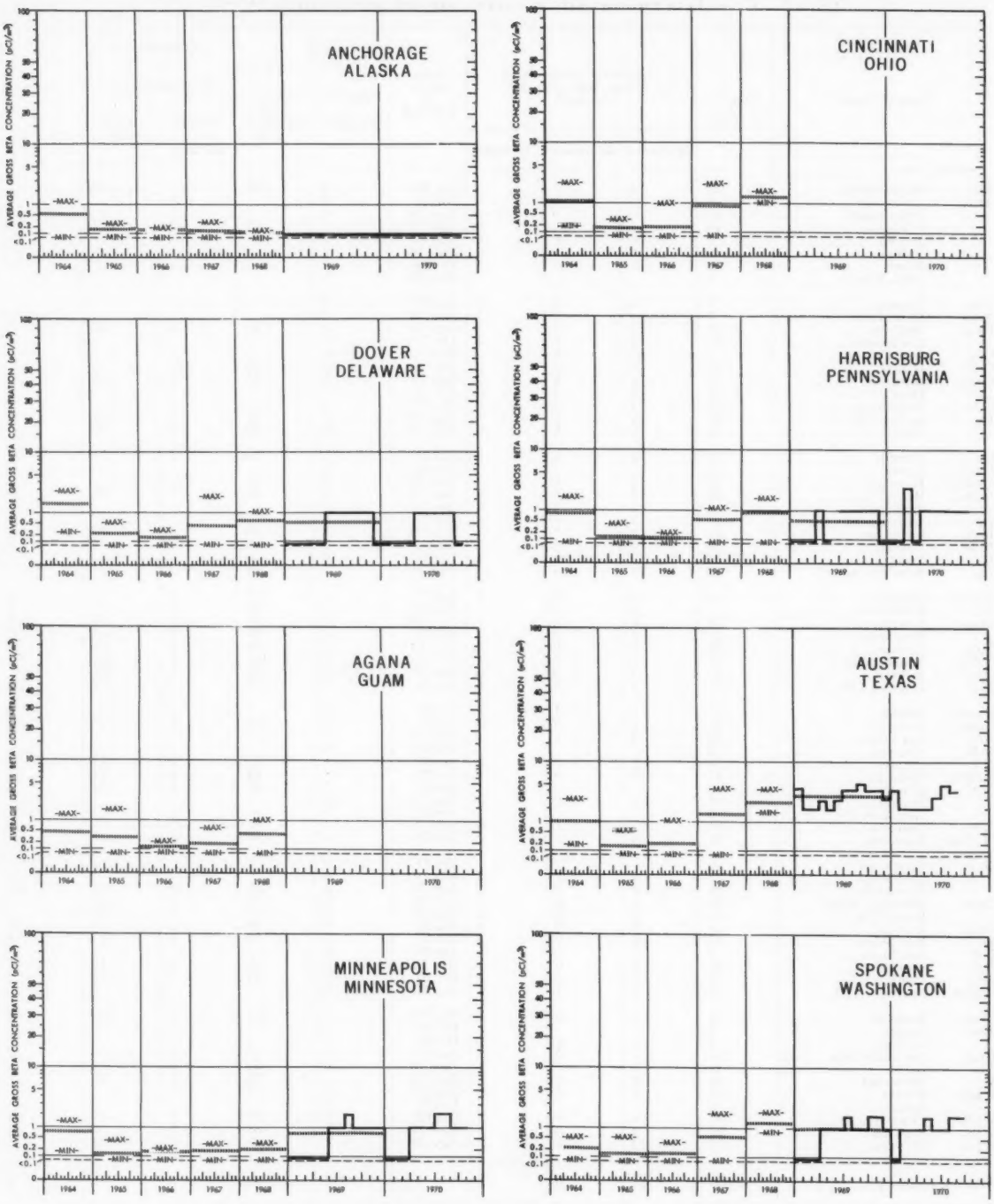


**Figure 2. Monthly and yearly profiles of beta radioactivity in air—Radiation Alert Network, 1964–October 1970**

## 2. Canadian Air and Precipitation Monitoring Program[1], October 1970

*Radiation Protection Division*
*Department of National Health and Welfare*

The Radiation Protection Division of the Canadian Department of National Health and Welfare monitors surface air and precipitation in connection with its Radioactive Fallout Study Program. Twenty-four collection stations are located at airports (figure 3), where the sampling equipment is operated by personnel from the Meteorological Services Branch of the Department of Transport. Detailed discussions of the sampling procedures, methods of analysis, and interpretation of results of the radioactive fallout program are contained in reports of the Department of National Health and Welfare (*1–5*).

A summary of the sampling procedures and methods of analysis was presented in the May 1969 issue of *Radiological Health Data and Reports.*

Surface air and precipitation data for October 1970 are presented in table 2.

[1] Prepared from information and data obtained from the Canadian Department of National Health and Welfare, Ottawa, Canada.

**Table 2. Canadian gross beta radioactivity in surface air and precipitation, October 1970**

| Station | Number of samples | Gross beta radioactivity (pCi/m³) | | | Precipitation measurements | |
|---|---|---|---|---|---|---|
| | | Maximum | Minimum | Average | Average concentration (pCi/liter) | Total deposition (nCi/m²) |
| Calgary | 9 | 0.2 | 0.1 | 0.1 | NS | NS |
| Coral Harbour | NS | | | | NS | NS |
| Edmonton | 12 | .2 | .0 | .1 | 22 | 0.9 |
| Ft. Churchill | 12 | .1 | .0 | .1 | 13 | 1.3 |
| Fredericton | 11 | .3 | .0 | .1 | 18 | 6.2 |
| Goose Bay | 11 | .3 | .0 | .1 | NS | NS |
| Halifax | 12 | .2 | .1 | .1 | 33 | 3.8 |
| Inuvik | 4 | .1 | .0 | .1 | 39 | 1.7 |
| Montreal | 5 | .1 | .0 | .1 | 15 | 3.0 |
| Moosonee | 12 | .2 | .0 | .1 | 27 | .9 |
| Ottawa | 11 | .1 | .0 | .1 | 28 | 1.8 |
| Quebec | 11 | .2 | .0 | .1 | 33 | 3.7 |
| Regina | 14 | .2 | .0 | .1 | 31 | 1.0 |
| Resolute | 3 | .1 | .1 | .1 | 44 | 2.1 |
| St. John's, Nfld | 12 | .1 | .0 | .1 | 21 | 3.2 |
| Saskatoon | 10 | .1 | .0 | .1 | 29 | 6.0 |
| Sault Ste. Marie | 12 | .1 | .0 | .1 | 28 | 2.3 |
| Thunder Bay | 11 | .2 | .0 | .1 | 36 | 6.1 |
| Toronto | 3 | .1 | .1 | .1 | 37 | 3.0 |
| Vancouver | 4 | .1 | .1 | .1 | 33 | 2.3 |
| Whitehorse | 11 | .1 | .0 | .1 | 70 | 3.5 |
| Windsor | 11 | .1 | .0 | .1 | 37 | 1.7 |
| Winnipeg | 11 | .2 | .0 | .1 | 56 | 1.5 |
| Yellowknife | 7 | .1 | .0 | .1 | 54 | 1.1 |
| Network summary | 219 | 0.3 | 0.0 | 0.1 | 34 | 2.7 |

NS, no sample.

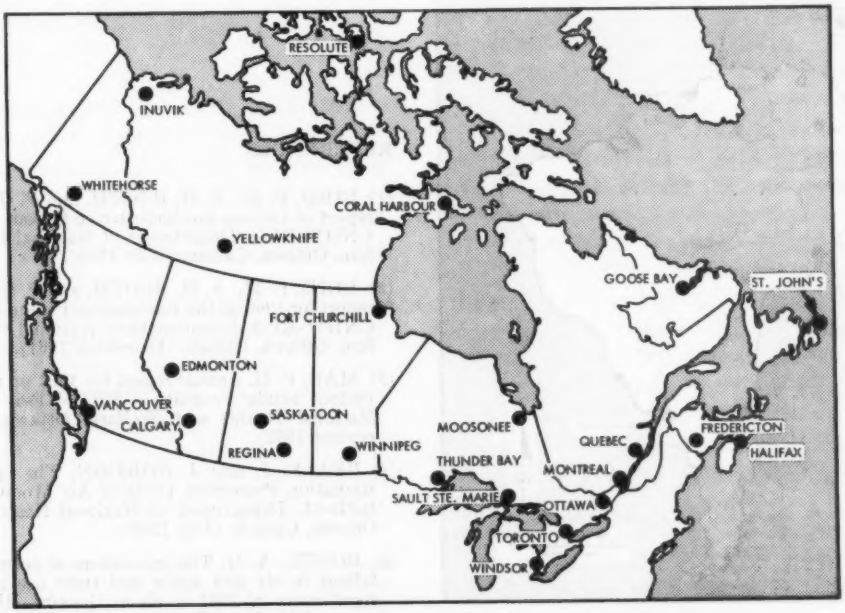


**Figure 3. Canadian air and precipitation sampling stations**

## 3. Pan American Air Sampling Program October 1970

*Pan American Health Organization* and
*U.S. Public Health Service*

Gross beta radioactivity in air is monitored by countries in the Americas under the auspices of the collaborative program developed by the Pan American Health Organization (PAHO) and the U.S. Public Health Service (PHS) to assist PAHO-member countries in developing radiological health programs.

The air sampling station locations are shown in figure 4. Analytical techniques were described in the March 1968 issue of *Radiological Health Data and Reports*. The October 1970 air monitoring results from the participating countries are given in table 3.

**Table 3. Summary of gross beta radioactivity in Pan American surface air, October 1970**

| Station location | | Number of samples | Gross beta radioactivity (pCi/m³) | | |
|---|---|---|---|---|---|
| | | | Maximum | Minimum | Average[a] |
| Argentina | Buenos Aires | NS | NS | NS | NS |
| Bolivia: | La Paz | 20 | 1.13 | 0.10 | 0.49 |
| Chile: | Santiago | 5 | .45 | .14 | .29 |
| Colombia: | Bogota | 20 | .10 | .00 | .03 |
| Ecuador: | Cuenca | NS | NS | NS | NS |
| | Guayaquil | NS | NS | NS | NS |
| | Quito | NS | NS | NS | NS |
| Guyana: | Georgetown | 14 | .19 | .01 | .10 |
| Jamaica: | Kingston | NS | NS | NS | NS |
| Peru: | Lima | 26 | 1.04 | .03 | .45 |
| Venezuela: | Caracas | 12 | .24 | .03 | .09 |
| West Indies: | Trinidad | 15 | .20 | .00 | .07 |
| Pan American summary | | 112 | 1.13 | 0.00 | 0.24 |

[a] The monthly average is calculated by weighting the individual samples with length of sampling period. Reported values of less than 0.005 pCi/m³ are considered as 0.00 pCi/m³ in averaging.
NS, no sample.


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# SECTION IV. OTHER DATA

This section presents results from routine sampling of biological materials and other media not reported in the previous sections. Included here are data such as those obtained from human bone sampling, Alaskan surveillance and environmental monitoring around nuclear facilities.

## Environmental Levels of Radioactivity at Atomic Energy Commission Installations

The U.S. Atomic Energy Commission (AEC) receives from its contractors semiannual reports on the environmental levels of radioactivity in the vicinity of major Commission installations. The reports include data from routine monitoring programs where operations are of such a nature that plant environmental surveys are required.

Releases of radioactive materials from AEC installations are governed by radiation standards set forth by AEC's Division of Operational Safety in directives published in the "AEC Manual."[1]

Summaries of the environmental radioactivity data follow for the Atomics International and Neutron Devices Department.

[1] Title 10, Code of Federal Regulations, Part 20, "Standards for Protection Against Radiation" contains essentially the standards published in Chapter 0524 of the AEC Manual.

### 1. Atomics International[2] January–June 1970

*North American Rockwell Corporation*
*Canoga Park, California*

Atomics International, a division of North American Rockwell Corporation, has engaged in atomic energy research and development since 1946. The company designs, develops, and constructs nuclear reactors for central station and compact power plants for medical, industrial, and scientific applications.

The company headquarters is located in Canoga Park, Calif., approximately 23 miles northwest of downtown Los Angeles. The 290-acre Nuclear Development Field Laboratory (Santa Susana Facility), equipped with extensive testing facilities for the support of advanced nuclear studies, is located in the Simi Hills of Ventura County, approximately 29 miles northwest of downtown Los Angeles. The location of the above sites in relation to nearby communities is shown in figure 1.

The basic concept of radiological hazard control at Atomics International requires adequate containment of radioactive materials and, through rigid operational controls, minimizes effluent releases and external radiation levels. The environmental monitoring program provides a measure of the effectiveness of the company's radiological safety procedures and of engineering safeguards incorporated into facility designs.

The onsite environs of Atomics International headquarters and Nuclear Development Field Laboratory (NDFL) are surveyed monthly to determine the concentration of radioactivity in typical surface soil, vegetation, and water samples. The offsite environs are sampled monthly, except for soil and vegetation which are sampled quarterly. In addition, continuous environmental air monitoring at the sites provides information concerning long-lived airborne particulate radioactivity.

#### *Air monitoring*

Environmental air sampling is conducted continuously at the headquarters and NDFL sites

[2] Summarized from "Environmental Monitoring, Semiannual Report, January 1, 1970 to June 30, 1970" Atomics International, Division of North American Rockwell Corporation.

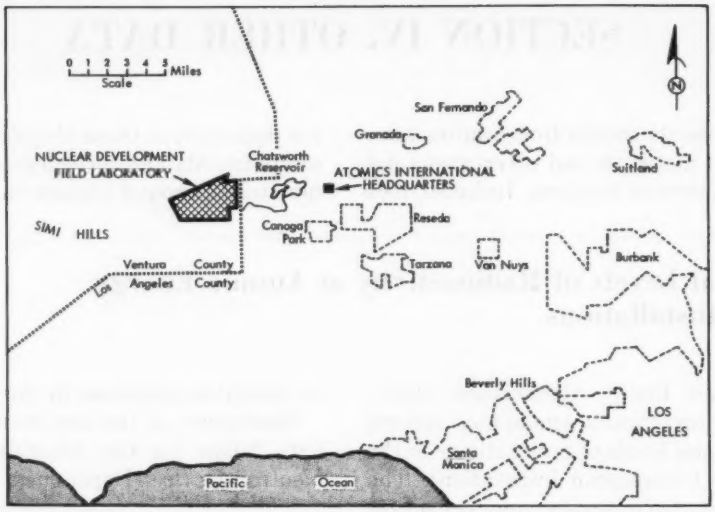


**Figure 1. Atomics International facilities and vicinity**

with automatic air samplers operating on 24-hour sampling cycles. Airborne particulate radioactivity is collected on HV-70 filter paper which is automatically changed at the end of each sampling period. The filter is removed from the sampler and counted after the radioactivity is allowed to decay for at least 72 hours. The volume of a typical daily environmental air sample is approximately 20 cubic meters. The average concentration of long-lived beta-gamma radioactivity on airborne particulates is presented in table 1 for January–June 1970.

**Table 1. Beta-gamma radioactivity of airborne particulates, Atomics International, January–June 1970**

| Location | Number of samples | Average concentration[a] (pCi/m³) |
|---|---|---|
| Headquarters | 324 | 0.46 |
| NDFL | 1,212 | .46 |

[a] Minimum detectable level—0.04 pCi/m³.

When abnormally high airborne radioactivities are observed, the radioactivity decay data are plotted to determine the presence of long-lived isotopes other than naturally occurring radon, thoron, and daughters. If fallout is suspected, the decay characteristics are observed. If the radioactivity decays as a function of $t^{-1.2}$, the data curve is extrapolated in order to determine the date of origin. These data are compared with the dates of publicized nuclear detonations to determine if the abnormal airborne radioactivity was caused by such detonations.

A graph of averaged long-lived airborne radioactivity concentrations detected at the Headquarters and NDFL facilities during the first half of 1970 is presented in figure 2. The graph shows a generally increasing trend through the spring months with a prominent peak noted in May.

*Water monitoring*

Process water used at the NDFL is obtained from Ventura County Water District No. 10 and distributed onsite by the same piping system previously used when process water was supplied by onsite wells. Pressure is provided by elevated storage tanks, one 50,000-gallon and one 500,000-gallon tank onsite. While clinically potable, the water is not used for drinking. Bottled potable water is delivered by a vendor and is not analyzed. Water from the pipe system is sampled monthly at two locations. The average process water radioactivity concentration is presented in table 2.

Soil, vegetation, and water are sampled monthly at Chatsworth Reservoir which is operated by the Los Angeles City Department of Water and Power. Normally, one water sample is obtained from the lake surface and a second sample is obtained from

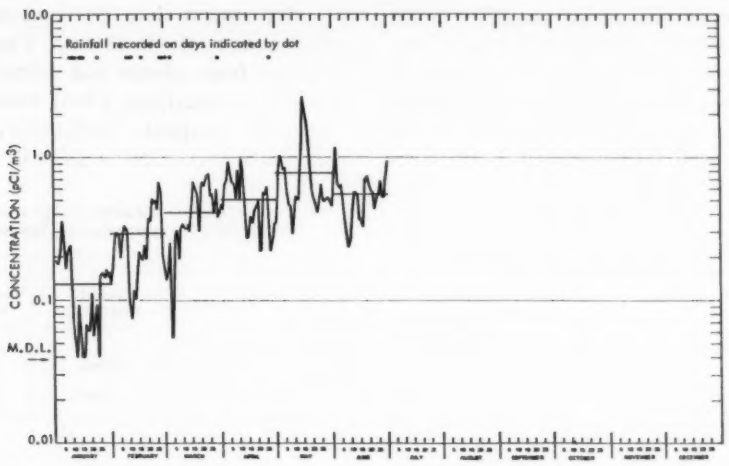


**Figure 2. Long-lived airborne radioactivity at Atomics International, 1970**

**Table 2. Process water radioactivity, NDFL site January–June 1970**

| Type of radioactivity | Number of samples | Average concentration (pCi/liter) |
|---|---|---|
| Alpha | 12 | 0.05 |
| Beta-gamma | 12 | 5.6 |

the reservoir water supply inlet located on the north side of the lake. The lake was drained in July 1969 for construction, thereby precluding sampling for most of the last half of 1969, and the current reporting period. The average radioactivity for both surface and supply water samples is presented in table 3.

**Table 3. Chatsworth Reservoir water radioactivity, Atomics International, January–June 1970**

| Sample[a] | Type of radioactivity | Number of samples | Average concentration (pCi/liter) |
|---|---|---|---|
| Supply inlet | Alpha | 6 | 0.18 |
| | Beta-gamma | 6 | 5.9 |

[a] No samples were collected from the lake surface for this period.

Surface discharged waters from NDFL facilities drain into holding reservoirs on adjacent property. When full, the main reservoir is drained into Bell Creek, a tributary of the Los Angeles River in the San Fernando Valley, Los Angeles County. Pursuant to the requirements of Los Angeles Regional Water Quality Control Board Resolution 66-49 of September 21, 1966, an environmental sampling station has been established in Bell Creek Canyon, approximately 2.5 miles downstream from the south NDFL boundary. Samples, obtained and analyzed monthly, include stream bed mud, vegetation, and water. Average radioactivity concentrations in the main holding reservoir and Bell Creek samples are presented in table 4.

**Table 4. Radioactivity in the Rocketdyne reservoir and Bell Creek,[a] January–June 1970**

| Sample description (units) | Number of samples | Alpha radioactivity | Beta radioactivity |
|---|---|---|---|
| Reservoir station 6, water (pCi/liter) | 6 | 0.05 | 6.7 |
| Reservoir station 12, water (pCi/liter) | 6 | .07 | 7.6 |
| Bell Creek, mud (pCi/g) | 6 | .34 | 25 |
| Bell Creek, vegetation (pCi/g ash) | 6 | .29 | 171 |
| Bell Creek, water (pCi/liter) | 6 | .019 | 4.0 |

[a] Location not shown on figure 1.

### *Soil and vegetation monitoring*

Soil and vegetation are regularly sampled at 25 locations. Eleven sampling stations are located within the boundaries of Atomics International's sites and are referred to as "onsite" stations. The remaining 14 stations, located within a 10-mile radius of sites, are referred to as "offsite" stations.

Surface soil types available for sampling range from decomposed granite to clay and loam. Samples are taken from the top half-inch layer of ground surface. The soil samples are packaged and sealed in plastic containers and returned to the laboratory for analysis. Radioactivity in soil samples is presented in table 5.

**Table 5. Radioactivity in the soil, Atomics International, January–June 1970**

| Area | Type of radioactivity | Number of samples | Average concentration (pCi/g) |
|---|---|---|---|
| Onsite | Alpha | 72 | 0.39 |
| | Beta-gamma | 72 | 28 |
| Offsite | Alpha | 24 | .41 |
| | Beta-gamma | 24 | 26 |

Vegetation samples obtained in the field are of the same plant type wherever possible, generally, sunflower or wild tobacco plant leaves. These types maintain a more active growth rate during the dry season than do most natural vegetation indigenous to the local area. Vegetation leaves are stripped from plants and transferred to the laboratory for analysis. Plant root systems are not routinely sampled. Radioactivity in vegetation samples is presented in table 6.

**Table 6. Radioactivity in vegetation, Atomics International, January–June 1970**

| Area | Type of radioactivity | Number of samples | Average concentration (pCi/g ash) |
|---|---|---|---|
| Onsite | Alpha | 72 | 0.41 |
| | Beta-gamma | 72 | 169 |
| Offsite | Alpha | 24 | .30 |
| | Beta-gamma | 24 | 154 |

Recent coverage in *Radiological Health Data and Reports*:

| Period | Issue |
|---|---|
| January–June 1969 | March 1970 |
| July–December 1969 | August 1970 |

## 2. Neutron Devices Department [3] January–June 1970

*General Electric Company*
*St. Petersburg, Fla.*

The Neutron Devices Department (figure 3) is an electronic component production facility. The plant maintains an environmental monitoring program to measure the levels of radioactive environmental contamination associated with plant effluents. These measurements serve as an index of the effectiveness of the plant's contamination control measures. Sewer effluent, surface water, milk and air within 6 miles of the plant are monitored for radioactivity. The radioactivity concentrations, weighted by atmospheric and stream dilution factors, are compared against the AEC standards for continuous nonoccupational exposure as presented in AEC Manual chapter 0524.

[3] Summarized from "Environmental Monitoring, January 1 through June 30, 1970," General Electric Company, Neutron Devices Department, St. Petersburg, Fla.

*Sewer effluent monitoring*

A combined sewer effluent sample is obtained daily near the perimeter of the plant's property. During the sampling period, 20 of 137 samples analyzed showed detectable concentrations of tritium (detectable level-90 nCi/liter). The maximum concentrations (1.10 μCi/liter, detected on January 20, 1970) represented 37 percent of the continuous nonoccupational exposure guide. Calculations based on radioactivity releases from the process waste system and the plant's water discharges indicate that the average tritium concentration in the combined sewer effluent for the first half of 1970 was less than 7.9 percent of the AEC standard for continuous nonoccupational exposure.

*Surface water sampling*

Surface water samples are collected at monthly intervals at selected locations within 6 miles of the plant. The sampling areas are determined by interrelating the concentrations of radioactivity in exhaust stack effluent with meteorological data. There were no indications of tritium (detectable

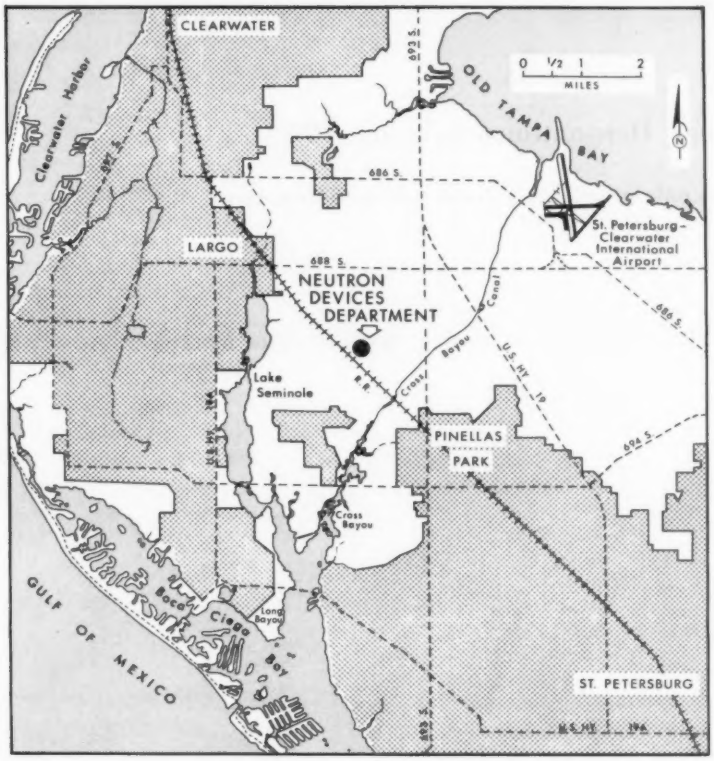


**Figure 3. Location of the Neutron Devices Department**

level-50 nCi/liter) in the 137 surface water samples analyzed during the sampling period.

*Milk sampling results*

Analyses of 14 milk samples, collected from one local dairy farm by the Pinellas County Health Department, revealed no detectable concentrations (detectable level-90 nCi/liter) of tritium.

*Air sampling results*

One tritium gas and three tritium oxide in air samples obtained at the perimeter of the plant property, downwind from the exhaust stack revealed no detectable amounts of tritium gas (detectable level-20 $\mu Ci/m^3$) or tritium oxide (detectable level-5 $nCi/m^3$).

*Summary*

Offsite radioactivity concentrations encountered by the general population are substantially lower than the AEC standards for continuous nonoccupational exposure.

Recent coverage in *Radiological Health Data and Reports*:

| Period | Issue |
|---|---|
| January–June 1969 | April 1970 |
| July–December 1969 | August 1970 |

## Reported Nuclear Detonations, January 1971

**Includes seismic signals presumably from foreign detonations**

There were no nuclear detonations or seismic signals reported by the U.S. Atomic Energy Commission for January 1971.

Information in this section is based on data received during the month, and is subject to change as additional information may become available. Persons requiring information for purposes of compiling announced nuclear detonation statistics are advised to contact the Division of Public Information, U.S. Atomic Energy Commission, Washington, D.C. 20545.

## SYNOPSES

Synopses of reports, incorporating a list of key words, are furnished below in reference card format for the convenience of readers who may wish to clip them for their files.

THE UPTAKE OF CERIUM-144, PROMETHIUM-147, AND PLUTONIUM-238 BY OAT PLANTS FROM SOILS. *S. L. Cummings and L. Bankert. Radiological Health Data and Reports, Vol. 12,* February 1971, pp. 83–85.

The uptakes of cerium-144, promethium-147, and plutonium-238 by oat plants were determined for nine soils, and promethium-147 and plutonium-238 uptakes compared with cerium-144 uptake. The percentage uptake values for all three radionuclides were very low, ranging from $10^{-6}$ to $10^{-3}$ percent. Nitrogen and potassium fertilizers increased the uptake of promethium-147 by oat plants from an Amite soil. Because the amount of cerium-144, promethium-147, and plutonium-238 taken up by plants from soils is very small, the health hazards to man by the soil-plant-man pathway from these radionuclides will probably be negligible at the levels used in this study.

KEYWORDS: cerium-144, fertilizers, oat plants, plutonium-238, promethium-147, soils, uptake.

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February 1971

# GUIDE FOR AUTHORS

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